



Patrick Vegetation Management Project

Draft Water Resources Report

January 2021

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Introduction

The following information was used to analyze existing conditions and the effects of the proposed actions and includes consideration of best available science:

1. District GIS data base (e.g. RHCA locations, topography, roads, location of treatment units, recent past harvest activities and past fire);
2. Field observations of stream flow, disturbance, channel morphology, vegetation, groundcover, species, canopy cover;
3. Review of historic and current land uses;
4. Vegetation data provided by the silviculturalist and LIDAR;
5. Scientific literature;
6. Stream order based on GIS maps;
7. Soils data from Natural Resources Conservation Service 2014 database;
8. Reports and discussions with other specialists;
9. Stream survey data; and
10. Prism climate data via FS WEPP.

Analysis Area

The Patrick Vegetation Management Project area (herein referred to as Project) is approximately 48,700 acres of National Forest System land. The entire project area (100%) is located within the North Fork Burnt River Watershed in the Wallowa-Whitman National Forest. There are six subwatersheds in the project area with elevations ranging from 4200 to 6030 feet above sea level (Table 1, Figure 1). The Headwaters North Fork Burnt River subwatershed (27.8% of project area) drains to the east and contains about 63 miles of streams (ranging from stream class 1 to 4). The North Fork of the Burnt River continues eastwards into the Patrick Creek-North Fork Burnt River subwatershed (16.6% of project area) and contains another 46 cumulative miles of streams to this network (1 to 4 stream classes). The Camp Creek subwatershed (35% of project area) to the north drains eastward and to the south to the conjunction of Camp Creek and the North Fork of Burnt River meet; a drainage network of about 81.5 miles (1 to 4 stream classes). To the south is the Petticoat Creek-North Fork Burnt River subwatershed (18.6% of project area). This drains northwards (about 44 miles of streams; 1 to 4 stream classes) to the confluence where Petticoat Creek and the North Fork Burnt River meet Trout Creek (1.2% of project area). The small lateral stream network to the east and north of the main channel within this subwatershed are not included in this project. The southernmost subwatershed is Antelope Creek (1.8% of project area). This has a little over 2 miles of creeks in the project area (3 and 4 class streams). Trout Creek subwatershed lies to the east of the Camp Creek subwatershed and north of Petticoat Creek-North Fork Burnt River watershed. There is a small portion here where the treatment units extend into this drainage basin but there are no creeks in the project areas here.

Table 1. Watershed and Subwatershed (SWS) Ownership for the Patrick Project

HUC 12 (SWS)	SWS Acres (Total)	Project Area Acres ¹	% of Total SWS	% Total Project Area	Elevation range within Project Area (ft)
Headwaters North Fork Burnt River (170502020101)	17,547	13,055	74.2	27.8	6030-4531 ft
Patrick Creek-North Fork Burnt River (170502030103)	9,716	8,101	83.4	16.6	5835-4344 ft

HUC 12 (SWS)	SWS Acres (Total)	Project Area Acres¹	% of Total SWS	% Total Project Area	Elevation range within Project Area (ft)
Petticoat Creek-North Fork Burnt River (170502030105)	14,839	9,078	61.2	18.6	5895-4380 ft
Camp Creek (170502020102)	18,778	17,060	90.8	35.0	5860-4249 ft
Trout Creek (170502020104)	19,703	566	2.9	1.2	5740-4383 ft
Antelope Creek (170502020108)	18,024	880	0.4	1.8	4740-4383 ft
Total	98,607	48,740	N/A	100	N/A

1. Excludes private land inholdings within the project area

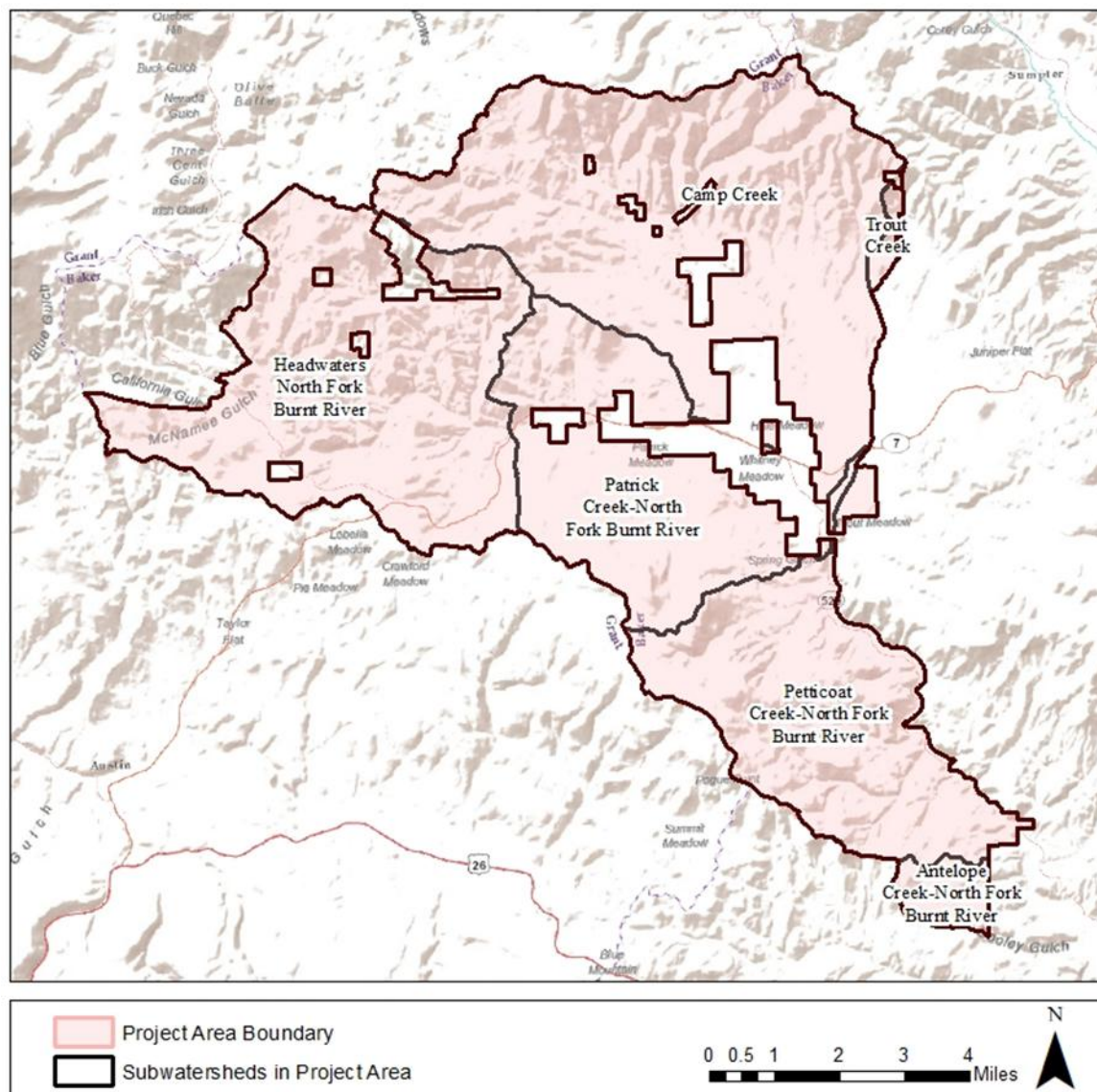


Figure 1. Project area map showing boundaries and subwatersheds

Past Management

The analysis area has a history of logging, small wildfires, road and railroad building, grazing and mining. Ongoing activities in the project area include noxious weed treatment, grazing, firewood cutting, mining, road maintenance, snowmobile and OHV use, dispersed camping and hunting. These past and current activities have all contributed to the existing condition of water resources in the project area.

Mining

The North Fork Burnt River watershed is known to hold many quartz veins and placer deposits, causing mining explorations to heavily occur from the 1860s through 1930s (Burch 1942). Placer mining and later dredge mining drastically changed the character of the watershed; erosion of stream banks, altered stream flows, damaging stream and riparian habitats are the result of dredging, lode mining and placer and hydraulic mining (USDA Forest Service 1995c). Due to the need for large quantities of water for placer and hydraulic operations, ditches were constructed to divert the needed water. This caused source streams

to be depleted of sufficient water to maintain the historic level of riparian vegetation (USDA Forest Service 1995c). The current conditions of the watershed reflect historic land use rather than historic or current watershed hydrology (USDA Forest Service 1995c).

Currently, mining companies have changed their environmental practices to be in congruence with the current Forest Plan standards and guidelines, and with the current Federal and State laws (USDA Forest Service 1995c). The Forest Plan goal for mineral management is, “to provide for exploration, development, and production of a variety of minerals on the Forest in coordination with other resource objectives, environmental considerations, and mining laws. To encourage and assist, whenever possible, the continuation of regional geologic mapping and mineral resource studies on the Forest in cooperation with other natural resource agencies” (USDA Forest Plan 1990, pp. 4-2).

Logging

Logging in the Wallowa-Whitman has occurred since the early 1900s with the railroad, through the present, with the vast majority occurring pre-1970 (USDA Forest Service 1995c). The project area has been logged multiple times. Railroad logging occurred in the project area beginning in the late 1800s and continued through the early 1900s (USDA Forest Service 1995c). Subsequent booms in the logging industry in the early decades of the 1900s resulted in removal of the majority of older, large diameter ponderosa pine trees from the lower elevations of the entire valley. During the early 1970s, most of the pine-dominated stands were pre-commercially thinned. Later harvest in the 1970s and 1980s removed large trees from higher elevations (USDA Forest Service 1995c). The records from 1979 to present represent a more continuous history of past activities. These past activities records as well as field evidence such as old landings, skid trails, railroad scars and stumps indicate that timber management activities date back as far as the early 1900s (Cuzick 2019, Silviculture Report). No logging has occurred inside most of the RHCAs since at least 1995 when the original INFISH RHCA buffers were put into place based upon management recommendations found in previous Forest management Plans (USDA Forest Service 1995c).

Railroads and Roads

With the development of the railroads in the area, the logging industry greatly expanded; the transportation of logs was faster and safer. The Sumpter Valley Railway began construction in 1901; this railroad followed the Powder River Valley, crossing over to the Burnt River Valley (North Fork), following Trout Creek Valley, down to the town of Whitney (Hug 1961). The railroad grades were developed up many stream bottoms, becoming roads when the track was pulled due to these areas being the easiest way to access forests and uplands (USDA Forest Service 1995c).

Roads have traditionally and historically followed river and stream courses. The result of both the railroads and roads are that nearly every perennial stream in the North Fork Burnt River Watershed has had a road or railroad grade located alongside it at one time or another. Along with placer mining, these early roads and railroads contributed to the development of the existing drainage network, larger channels, and the increased rate at which groundwater and surface water leave the project area.

Beginning in the late 1960's, road construction associated with accelerated timber harvest on National Forest system lands greatly increased the number of roads. Many of these newer roads were located on slopes, away from streams where possible, and designed with permanent drainage features.

Grazing

Livestock grazing within the Project area supports traditional lifestyles and helps to support local economies (USDA Forest Service 1995c). Historically, livestock grazing also contributed to the changes

in the project area. Impacts can be observed within the understory vegetation, infiltration rates and runoff volumes. Historic livestock grazing would have decreased infiltration rates as a result of soil compaction, altered runoff and infiltration as a result of compaction and changes in the ground cover, decreased bank stability by trampling and removal of riparian vegetation. These changes would have contributed to the expansion of the drainage network by increasing stream flows and erosion during storm events.

Climate

Climate is warming across the Pacific Northwest and is altering the volume, timing, and quality of water received from winter snowpack. Historic observations show increased dryness accompanying more widespread wildfire and forest die-off (USDA Forest Service 2014b). Streamflow declines are linked to decreases and changes in the westerlies, winter winds that bring precipitation to mountains across the region (Luce et al. 2013). Projections under future climate change scenarios indicate decreases in winter winds leading to decreased precipitation in the mountains. Decreased precipitation will exacerbate early snowmelt tied to warming temperatures and lead to reduced stream flows and runoff, impacting the region's water supply and ecology (USDA Forest Service 2014b). Lundquist et al. (2013) combined an analysis of forest cover studies across the globe with modeling as it pertains to snow retention and found the following:

“...regions with average December-January-February temperatures greater than -1°C (30.2°F), forest cover reduces snow duration by 1 to 2 weeks compared to adjacent areas. This occurs because the dominant effect of forest cover shifts from slowing snowmelt by shading the snow and blocking the wind to accelerating snowmelt from increasing longwave radiation. In many locations, midwinter melt removes forest snow below solar radiation is great enough for forest shading to matter, and with warming temperatures, midwinter melt is likely to become more widespread. (p. 6356)”

The predictions of increased periods of drought and earlier runoff in the spring are expected to result in widespread threats to forest resulting from drought stress (Grant et al. 2013). Choat et al. (2012) found that 70% of the 226 forest species they examined on 81 sites worldwide operate within narrow hydraulic safety margins against injury due to drought stress. They concluded that many forest species, and particularly project area pine species like Ponderosa pine, potentially face long-term reductions in productivity and survival if temperature and aridity increase as predicted for many regions across the globe. In addition, they found that all forest biomes equally vulnerable to hydraulic failure regardless of their current rainfall environment. The reduction in runoff and increased periods of drought will increase the potential of large-scale, high intensity wildfires and insect outbreaks as well as impact downstream users of water and species dependent on existing habitat.

Temperature and precipitation for the Headwaters North Fork Burnt River, Patrick Creek-North Fork Burnt River, Trout Creek, Petticoat-North Fork Burnt River, and Antelope Creek subwatersheds was estimated using the Forest Service PRISM program (<http://forest.moscowfsl.wsu.edu/cgi-bin/fswcpp/rc/modpar.pl>) and the Huntington, OR climate station. Two elevations were used for these subwatersheds to capture a range in temperature and precipitation for the portion of the subwatershed area within the project boundary. The elevations are different for each subwatershed as a result of what the PRISM model would allow based on the latitude and longitude values it was given. The driest months are July through October (Table 20). The warmest months are June through August resulting in high potential evapotranspiration rates (Table 21).

SOIL WATER AVAILABLE TO PLANTS

Background

While climate determines the amount, type and timing of precipitation in an area, the characteristics of the canopy cover (i.e. species, number of intercepting layers, % open) influence how much of that precipitation reaches the ground. The characteristics of the ground cover and the underlying soils, in turn, influence whether the precipitation infiltrates into the soil or becomes runoff. Once water is in the soil, soil properties and degree of soil saturation determine how much of the water can drain freely and contribute to stream flows, how much is available to plants for use, and how much remains held by the soil particles. In areas where plants remove more water than the amount supplied by precipitation, soil water can be key in buffering the plant root environments against periods of water deficit (USDA NRCS 1998, USDA NRCS 2008).

The amount of water that a soil has the potential to store and make available to plant is called the available water capacity (AWC). Its value varies as a function of soil properties. It is somewhat a fixed soil property, though organic matter can increase its values and compaction, erosion, and displacement can decrease it (USDA NRCS 1998). Given the AWC of a soil, the amount of water actually stored and available to plants then becomes a matter of precipitation inputs (snow and rain). As the amount of precipitation that reaches the ground decreases (i.e. reduced precipitation, increased interception), the amount of water that can infiltrate and be available for use by plants also decreases. As densities of vegetation increase, the competition for existing available soil water increases.

In the project area, the potential water demands by plants are expected to be high in June through August because air temperatures are high (Table 21). Whether actual evapotranspiration is equal to or less than potential evapotranspiration during these months will depend in part on the amount of soil water that exists during the summer months and is available to plants. Therefore, to determine the potential for project area soils to buffer plant root systems against periods of drought, the available water capacities of project area soils were calculated. Soil series with low AWCs have limited ability to store water that plants can utilize and are considered droughty soils. In areas where the potential evapotranspiration rates are high and precipitation inputs low, droughty soils have limited ability to buffer the plant roots against periods of water deficit. Plants species and plant densities in these conditions become important in determining potential for plant stress and potential for large-scale, high intensity wildfires (or insect outbreaks) and thus increased runoff and soil erosion during post-wildfire precipitation event.

Calculation Method

The AWC values were calculated for the top soil and total profile for each soil series in a map unit using data contained in the NRCS TEUI soil survey data sheets (websoilsurvey.nrcs.usda.gov). All soil series within a map unit were used to calculate the AWCs resulting a weighted AWC value. All soils series within a map unit were used rather than the dominant soil series because 1) many map units had two soil series of almost equal value (for example, 55/45 split) or 2) the percent contribution to a map unit of the two-subordinate series (where three series) were more similar to each other than to the dominant series. Often the combined percentage of the subordinate soil series exceeded the percent contribution of the dominant series. Individual values for each soil series within a map unit and their weighted values are found in Appendix A.

Top soil in the project area was identified as the Oi, A, AB, and Bw horizons. The AWC for the top soil was examined because this is the zone where many understory non-conifer vegetation types (grasses, forbs, herbaceous and shrubs) and the conifer seedlings have some or all of their roots. This is also the portion of the soil profile that can capture precipitation during short precipitation events provided that the

water reaches the ground and infiltrates. It is also the portion of the soil profile that is sensitive to compaction and disturbance. The AWCs for the entire soil profile were examined because trees and some shrubs have rooting depths that extend below the top soil and can tap into subsoil water. The source of water in this zone comes from deep infiltration that can occur during the spring snow melt and via the movement of groundwater from upslope areas.

Once calculated, the AWC values are grouped into classes and given a qualitative rating (Table 2), with the rating specific to the project area (USDA NRCS 1998). For the project area, top soil or total soil profiles with AWC values of 6 inches or less are considered droughty soils. Soils with an AWC of 6 to 9 inch are given a medium AWC rating. This is the range where aspect and elevation become increasingly important in determining the degree of stress plants could experience. For example, plants on north-facing slopes tend to be less stressed than plants on south-facing slopes for the same map unit because southerly slopes receive more direct solar energy and thus potential evapotranspiration is greater. Plants at higher elevations are also less stressed than those at lower elevations for the same map unit because potential evapotranspiration is lower and available soil moisture higher. Soils with AWC values greater than 9 inches are considered soils with a high AWC. No soils in the project area had weighted AWC values greater than 12 inches.

Table 2. Available Water Capacity (AWC) categories identified for the project area.

Available water capacity (inches)	AWC Class
0 to 3	Very low (droughty soil)
3 to 6	Low (droughty soil)
6 to 9	Medium
9 to 12	High
>12	Very High

Results

The weighted AWC results are presented by subwatershed (Table 3). The spatial distributions of the AWC values are shown in Figure 2 (total soil profile). The weighted AWC values for the top soil indicate that the majority of the top soils are droughty. With respect to the total soil profile, 44 to 99% of the subwatersheds have droughty soils. The remaining AWC values in the subwatersheds fall into the 6 to 9 inch range (1-31%). This range is considered a medium AWC. Given that these two subwatersheds are south facing and at elevations ranging from 4380 to 5918, their ability to meet the water demands of vegetation in the area may be lower than the medium AWC suggests. The remaining AWC values are in the 9 to 12 inch range and occur in small pockets scattered throughout these subwatersheds (Table 3). Typically, the higher AWC values are seen in flatter lower elevation portions of the watersheds, while the headwaters areas and steeper portions of the watersheds tended toward the lower AWC values.

Table 3. Subwatershed acres by weighted AWC ranges for the top soil and total soil. Elevation and aspect included.

Elevation Range (ft)	Aspect	Profile	Profile Depth (inches)	AWC range (inches) – Weighted Available Water Capacity	0 to 3 inches (acres) – Weighted Available Water Capacity	3 to 6 inches (acres) – Weighted Available Water Capacity	6 to 9 inches (acres) – Weighted Available Water Capacity	9 to 12 inches (acres) – Weighted Available Water Capacity	>12 inches (acres) – Weighted Available Water Capacity
Headwaters North Fork Burnt River (13,055 acres) ¹									
5151 to 4531	East Facing	Top Soil Only	0 to 18	0.00 to 2.16	13055.3 (100%)	0	0	0	0

Elevation Range (ft)	Aspect	Profile	Profile Depth (inches)	AWC range (inches) – Weighted Available Water Capacity	0 to 3 inches (acres) – Weighted Available Water Capacity	3 to 6 inches (acres) – Weighted Available Water Capacity	6 to 9 inches (acres) – Weighted Available Water Capacity	9 to 12 inches (acres) – Weighted Available Water Capacity	>12 inches (acres) – Weighted Available Water Capacity
		Total Soil Profile	0 to 79	0.00 to 10.54	4690.0 (36%)	2556.4 (20%)	4091.4 (31%)	1717.3 (13%)	0
Patrick Creek-North Fork Burnt River (8,101 acres) ¹									
5502 to 4344	South Facing	Top Soil Only	2 to 22	0.20 to 1.98	8101.2 (100%)	0	0	0	0
		Total Soil Profile	7 to 79	0.70 to 10.54	2095.6 (26%)	1467.9 (18%)	3035.7 (37%)	1502.3 (19%)	0
Petticoat Creek-North Fork Burnt River (9,078 acres) ¹									
4593 to 4380	South Facing	Top Soil Only	0 to 22	0.00 to 1.98	9078.2 (100%)	0	0	0	0
		Total Soil Profile	0 to 72	0.00 to 11.39	2984.0 (33%)	1932.7 (21%)	3553.3 (40%)	557.9 (6%)	0
Camp Creek (17,060 acres) ¹									
5918 to 4249	South Facing	Top Soil Only	3 to 36	0.20 to 2.52	17059.9 (100%)	0	0	0	0
		Total Soil Profile	7 to 72	0.70 to 9.00	2320.9 (13%)	13529.5 (79%)	1209.6 (7%)	0	0
Trout Creek (566 acres) ¹									
4593 to 4383	South Facing	Top Soil Only	2 to 22	0.20 to 1.98	565.9 (100%)	0	0	0	0
		Total Soil Profile	7 to 72	0.70 to 9.00	5.3 (1%)	555.3 (98%)	5.2 (1%)	0	0
Antelope Creek-North Fork Burnt River (880 acres) ¹									
4383 to 4380	South Facing	Top Soil Only	2 to 14	0.22 to 1.68	880.4 (100%)	0	0	0	0
		Total Soil Profile	7 to 67	0.70 to 11.39	621.2 (71 %)	80.9 (9%)	54.1 (6%)	124.2 (14%)	0

1. The total TEUI acres inside the Project Area Boundary are less than the total SWS acres inside the Project Area Boundary because there are slivers where the TEUI data do not meet the Project Area Boundary.

In conclusion, droughty soils (low AWC) dominate in the top soil regardless of subwatershed. When considered in combination with low precipitation and warm air temperatures in July and August, the top soil-drought potential is expected to be high. Depending on the distribution of summer precipitation and amount that reaches the ground, plants that have their roots in this zone are expected to be either water-stressed or drought-tolerant species. When the total soil profile is examined, droughty soils make up only about 50% in each watershed with the remaining in the medium to high AWC range. In all cases, how much precipitation (snow and rain) is intercepted by the canopy cover and evaporates prior to reaching the ground and how much infiltrates into the ground determines water availability and thus potential water stress on project area vegetation.

According to the silviculture report (Cuzick, 2019), the project area consists of stands with a significant increase in canopy cover as compared to historic conditions. The silviculture report lists historic range of variability (HRV) for closed canopy for dry upland forest at 5-20%, with current conditions at 56%; for open cold upland forest at 20-30% HRV and current conditions at 64%; for open moist upland forest at 30-40% HRV and current conditions at 68%. With increase in canopy closure, there is an increase in demand on AWC leading to an increase in stress on trees making them more susceptible to insects, disease, wildfire and mortality.

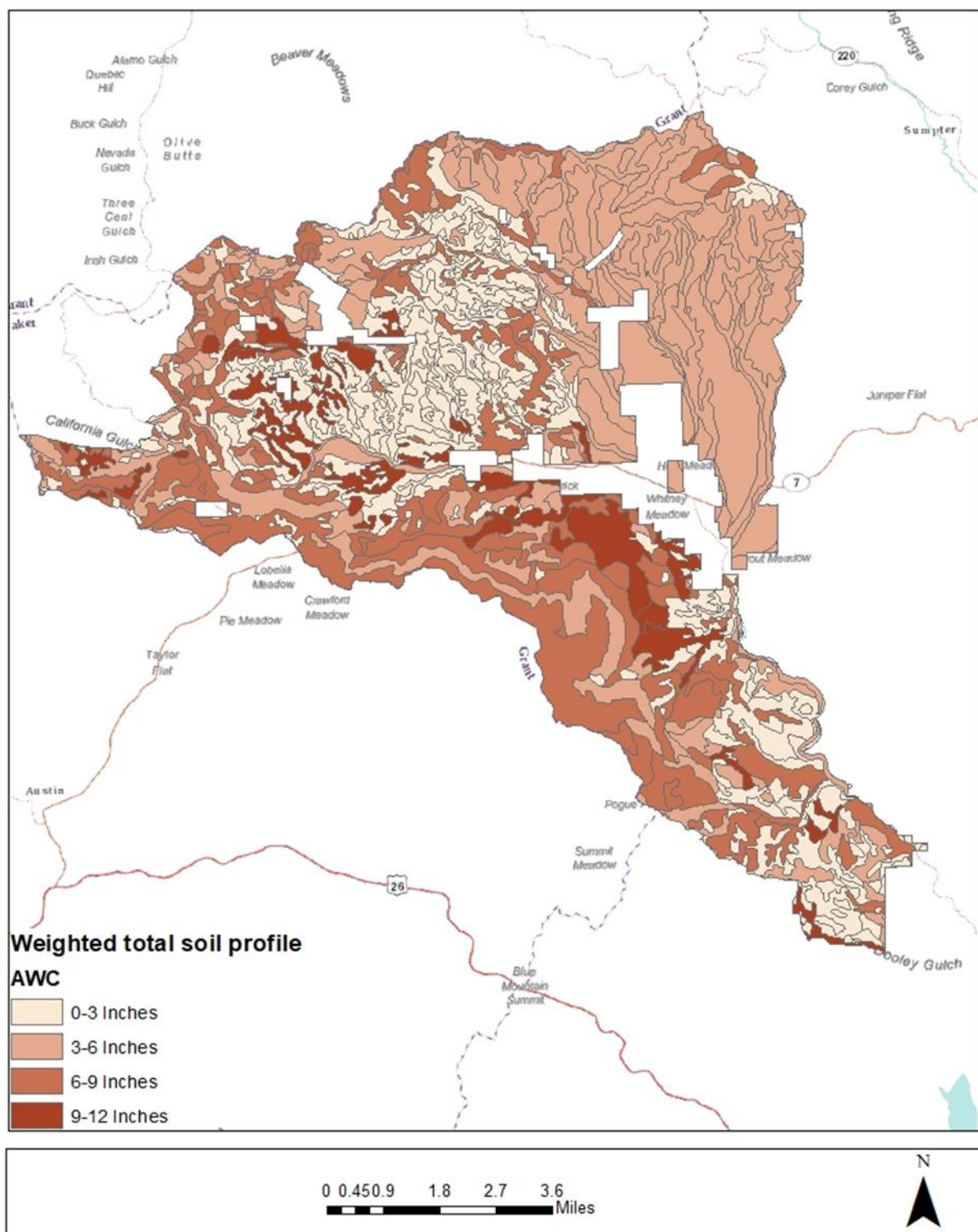


Figure 2. Available Water Capacity (AWC) values of the TEUI soils in the project area for the total soil profile.

Vegetation Characteristics and Water Demand

Canopy Cover

Existing canopy cover was estimated for each unit using NRM FSVeg Data Analyzer program. The model includes in its estimate all of the trees regardless of their height. Therefore, areas with a large number of small trees (less than 0.1 inch dbh), or have multiple layers, or only an over story of large trees and an understory of seedlings may have similar existing canopy cover values.

Canopy cover across the project area ranges from 0 to 100 percent. Existing canopy cover in the proposed harvest units ranges from 2 to 100 percent and are summarized below by subwatershed and treatment proposed to allow for comparison with post-treatment results discussed in the effects analysis (Table 4). However, it is not just the percent cover but the characteristics of the canopy cover that influence how much precipitation reaches the ground. Characteristics of importance include type of species (i.e. grand fir vs. Ponderosa pine), trees per acre and their mix of sizes (i.e. seedlings, saplings, trees), number of layers and type of species creating the layers. Grand fir, and to a less extent Douglas-fir, are more effective at intercepting precipitation given their needle type and low dense branching structure than Ponderosa pine which has a more open structure (USDA Forest 2014c). Therefore, in multi-story stands where grand fir or Douglas-fir are abundant, less water reaches the ground and soil moisture conditions would be drier than in multi-layered stands composed of mainly Ponderosa pine. As grand fir or Douglas-fir becomes a greater part of the understory or the number of grand fir or Douglas-fir layers increases, the amount of water reaching the ground decreases.

Table 4. Existing canopy cover (CC) by proposed treatment by subwatershed.

Subwatershed Name	Prescription	CC Range	CC Average
Headwaters North Fork Burnt River	Defensible Fuel Profile Zone (DFPZ):Thinning from Below (HTH)_ Precommercial Thin (PCT)	5-100	83
	DFPZ: HTH_PCT_Post and Pole (P&P)	10-100	85
	DFPZ: HTH_PCT_Prescription burn (Rxburn)	2-100	71
	DFPZ: No Treatment	10-100	76
	DFPZ: PCT	4--90	38
	DFPZ: PCT_Rxburn	10-100	59
	DFPZ: Rxburn	15-64	42
	HTH_PCT	2-100	68
	HTH_PCT_P&P	15-100	75
	HTH_PCT_Rxburn	2-100	66
	HTH_Rxburn	55	55
	No Treatment	10-100	70
	PCT	1-100	47
	PCT_Rxburn	4-100	56
	Rxburn	5-100	93
Patrick Creek-North Fork Burnt River	DFPZ: HTH_PCT	**	**
	DFPZ: HTH_PCT_Rxburn	40-100	70
	HTH_Aspen_PCT_Rxburn	**	**

Subwatershed Name	Prescription	CC Range	CC Average
	HTH_PCT	50-100	96
	HTH_PCT_P&P	5-100	45
	HTH_PCT_Rxburn	5-100	42
	HTH_Rxburn	40-100	77
	No Treatment	4--62	33
	PCT	10	10
	PCT_Rxburn	16-62	33
	Rxburn	10-100	32
	DFPZ_Rxburn	**	**
Petticoat Creek- North Fork Burnt River	DFPZ: HTH_PCT_Rxburn	**	**
	DFPZ: No Treatment	**	**
	DFPZ: PCT_Rxburn	**	**
	DFPZ: Rxburn	**	**
	HTH_PCT	**	**
	HTH_PCT_P&P	**	**
	HTH_PCT_Rxburn	25-83	37
	No Treatment	**	**
	PCT	**	**
	PCT_Rxburn	**	**
	Rxburn	25-75	29
Camp Creek	DFPZ: HTH_PCT	25-86	58
	DFPZ: HTH_PCT_Rxburn	15-100	56
	DFPZ: HTH_Rxburn	25-100	45
	DFPZ: No Treatment	20-75	48
	DFPZ: PCT	10-100	39
	DFPZ: PCT_Rxburn	20-100	52
	DFPZ: Rxburn	5--85	47
	HTH_PCT	10-100	55
	HTH_PCT_Rxburn	5-100	51
	HTH_Rxburn	5-100	44
	No Treatment	4-100	33
	PCT	10-100	38
	PCT_Rxburn	2-100	50
	Rxburn	5-100	43
Trout Creek	DFPZ: HTH_Rxburn	40-65	45
	DFPZ: PCT_Rxburn	35	**
	HTH_PCT_Rxburn	30-100	33

Subwatershed Name	Prescription	CC Range	CC Average
	HTH_Rxburn	23-92	35
	No Treatment	20-55	41
	PCT_Rxburn	25-54	33
	Rxburn	30-40	35
Antelope Creek	HTH_PCT_Rxburn	10--92	60
	PCT_Rxburn	25-100	65
	Rxburn	10--83	30

Trees per Acre (TPA)

The dominant forested stands in the project area are ponderosa pine and mixed conifer forests. A review of the stand exam and LIDAR data shows that most of the area is multi-storied. The nature of the multi-story varies from two layers (seedlings and larger overstory) to three or more layers. Lodgepole and Ponderosa-Mixed Conifer comprise a large percentage of the overstory in a large part of the project area. Figure 4 (Appendix B) shows the distribution of the TPA for the project area.

On average, the DBH for the project area ranges from 5-12 inches, with an average of 6.6 inches. This size is likely tapping into the top soil moisture. As previously noted above, most of available water capacity (AWC) of the top soil is less than 6 inches and considered a droughty zone. In addition, grand fir and Douglas-fir dominate the understory in many stands within the project area. These stands are for the most part multi-storied with some top and single stories mixed in. These species limit the amount of precipitation (snow and rain) that can reach the ground and potentially infiltrate and provide water to plants. The net result is high competition for a limited amount of water resulting in elevated levels of water stress, during the summer for plants that have their root systems in the top soil. The increased water stress leads to an increase in susceptibility to insects and disease, reduction in growth and mortality.

The multiple canopy layers and overstocking in much of the understory also impact inputs of moisture into the subsoil because they effectively intercept snow. This reduces the depth of the snow pack on the ground, snowpack retention, snow pack redistribution and the amount of water that melts in the spring and can potentially contribute to deep infiltration. As noted by Lundquist et al. (2013), forest cover also influences the type and amount of radiation (long-wave vs. short-wave) that reaches the ground and depending on the mean monthly air temperatures in December, January, and February can decrease the length of time that snow remains on the ground for later contributions to the soil water and stream flows.

Additional water losses to the soil profiles are seen within the project area due to an increase in stocking density. High stocking density increases the amount of water lost back to the atmosphere through evapotranspiration. The overall water losses, especially from the high evapotranspiration of western juniper, lead to a decrease in watershed base flows.

While only 50% of the total soil profiles in the project area are considered droughty soils (AWC < 6 inches), the high interception of snow and rain by the multiple canopy layers combined with predictions of warmer winter temperatures are decreasing inputs of water into the soil such that even soils with medium to high AWC values may not be holding their full water potential. The result is that even those trees whose root systems access the entire soil profile in areas with medium to high AWC values may be experiencing water-stress.

Ground Cover

The amount and type of ground cover influences the potential for soil erosion from rain splash or overland flow and infiltration of precipitation (Belt et al 1992; Larsen et al 2009; Mohammad and Adam 2010; Robichaud et al 2000; Rogers and Schumm 1991). As the amount of ground cover and surface roughness increases, soil erosion and the distance that soil can travel decreases. The type of live ground cover determines the rate of vegetative recovery post wildfire or prescribed burn, and the potential for soil sealing and enhanced runoff and soil erosion post wildfire. The type of ground cover also influences the expected contributions of organic matter into the soil which in turn influences the water holding capacity of the soil.

Ground cover varied between 70 and 100%. The key understory shrubs (oceanspray, common snowberry, mountain mahogany, thinleaf huckleberry, and spirea) and grasses (pinegrass and Geyer's sedge) in the uplands have rhizomatous rooting systems and use the upper 12 inches of the soil profile. They have varying degrees of drought tolerance. Currently, their abundance is limited due to competition from conifers for water, space and light.

DRAINAGE DENSITY

The existing drainage density (miles/sq. mile) is a combination of stream channels and existing road segments and is the result of watershed hydrology and past and current land uses. The drainage density influences the rate and paths by which water leaves a watershed. Past land uses contributed to the development of channels in drainages that historically may have been only unchannelized draws. In some cases, the channels that developed were continuous and are now part of the existing stream drainage network. In other cases, channelization occurred for only short segments (i.e. discontinuous channels) and may or may not have perennial flow or pockets of standing water. The discontinuous channels are not considered part of the existing drainage network because they are unable to transport water downstream via channelized flow and are not talked about further.

The total drainage density (streams plus existing roads) is the sum of stream miles and contributing road segments. Road contributions to the drainage density was estimated by examining the number of existing road-stream crossings on open, closed and existing non-system templates. Roads are included because of their ability to intercept subsurface water (through flow), convert it to surface flow, potentially transport it into the streams, and increase stream flows (Megahan 1972; Wemple et al. 1996; Jones and Grant 1996; Wemple and Jones 2003).

Contribution from road/stream crossings and drainage features along roads was modeled based on the following methods. Two contribution lengths were selected to estimate the potential range of contribution of road/stream crossings to the drainage density range: 1) 200 feet and 2) 600 feet. These values were selected based on field work (Rabe Consulting 2018) that found that road drainage features in the project area were 200 to 600 feet apart thus limiting the amount of road that could contribute water and sediment to a stream at a crossing. The contribution would be considered 100 ft on each side of the drainage feature (total 200ft per contribution), which would account for the close 200 ft spacing, making sure all of the road network was considered if the features were all 200ft apart. The contribution would be considered 300 ft on each side of the drainage feature (total of 600ft per contribution), which would account for the more spaced drainage features (approximately 600ft apart). Therefore, the estimates are considering the close and far spacing of drainage features to the contribution from the road network. This provides a high and low range of the contribution to be considered.

The majority of the existing road/stream crossings occur in the Headwaters North Fork Burnt River, Patrick Creek-North Fork Burnt River, Petticoat Creek-North Fork Burnt River, and Camp Creek

Subwatersheds (Table 5). Table 6 shows the existing drainage miles and density for the all six of the subwatersheds that contain this project.

Table 5. Miles of road and number of road/stream crossings by subwatershed and road status.

Subwatershed Name	TOTAL Road miles¹	# Road/Stream Crossings for All OPEN Roads (FS, private, State, County)	# Road/Stream Crossings for FS CLOSED/ Decommissioned Roads	Total
Headwaters North Fork Burnt River	133.3	130	13	143
Patrick Creek-North Fork Burnt River	69.6	43	4	47
Petticoat Creek-North Fork Burnt River	92.7	117	12	129
Camp Creek	179.8	145	7	152
Trout Creek	18.03	0	0	0
Antelope Creek	9.8	12	4	16

1. Includes road miles within the Project Area portion of subwatershed.

Table 6. Drainage density as a result of streams and the existing road network within the Project Area by subwatershed.

HUC 12 (SWS) name	Project Area (sq. miles)	Stream miles	Stream density (miles/sq. mile)	# Road crossings	Road miles intersecting streams via stream crossings		Stream + Road miles contributing to the drainage network		Stream + Road drainage density (miles/sq. mile)	
					100 ft/side or 200 feet total contribution	300 ft/side or 600 ft total contribution	If roads contributing 200 feet of total length per crossing	If roads contributing 600 feet of total length per crossing	If roads contributing 200 feet of total length per crossing	If roads contributing 600 feet of total length per crossing
Headwaters North Fork Burnt River										
	20.4	61	3	143	5.4	16.3	66.4	77.3	3.3	3.8
Patrick Creek-North Fork Burnt River										
	12.7	33.7	2.7	47	1.8	5.3	35.5	39	2.8	3.1
Petticoat Creek-North Fork Burnt River										
	14.2	42.4	3	129	4.9	14.7	47.3	57.1	3.3	4
Camp Creek										
	26.7	73.5	2.8	152	5.8	17.3	79.3	90.8	3	3.4
Trout Creek										
	0.9	0.1	0	0	0	0	0	0	0	0
Antelope Creek										
	1.4	3.1	2.2	16	0.6	1.8	3.7	4.9	2.6	3.5

Drainage densities increased when the road/stream crossing segments were added, with the exception of the Trout Creek Subwatershed which had essentially no streams in the Project Area portion of the subwatershed (Table 6). The potential contribution to the drainage density from existing roads ranged from 4 to 18% under the 200 ft contribution and 15 to 42% if the 600 ft contribution was used. As stated in Wemple et al. (1996, p. 1202), the above estimated increases in drainage density are “...sensitive to the assumptions about the length of pre-existing stream network and which road segments may truly be considered connected to the stream...” In addition, hydrologic integration of portions of the road as part of the drainage network will vary “in response to seasonal expansion and contribution of the stream network [and] may be best thought of as varying dynamically in space throughout a season.”

While the road/stream crossings are easily determined using GIS, road drainage features, which can also add to the drainage network, must be identified in the field. Therefore, two roads (1060 and 1044-Geiser Creek Road) were examined as representative examples to assess the frequency of road drainage features and their potential contribution to the total drainage density. These roads were selected because one parallels perennial, fish-bearing streams for its entire length and in places are less than 25 feet from the creek and the other crosses major drainages within the Camp Creek subwatershed. Road 1044, which travels 8.5 miles along (parallel) Geiser Creek, has an aggregate/gravel surface. This road has 14 road/stream crossings and 22 other road drainage features. Road 1060 crosses major drainages but does not parallel a creek and is a native surface, though it is highly armored in places by large rock. This road has 6 road/stream crossings and 25 road drainage features. Distances between drainage features ranged from 200 to 600 feet based on field observations (Rabe Consulting 2018).

While the road drainage features identified on Road 1044 and Road 1060 may contribute some additional length where roadside ditches exist in the fillslope and connect to the stream during high flow, connected roadside ditches were rare and their contribution to the drainage density is expected to be small. As for the remaining roads in the project area, they either intersect streams at right angles or parallel a stream for only short segments. Therefore, the number of other road drainage features that might contribute water and sediment to the channel via gullies connected to the streams is expected to be low.

STREAM/RIPARIAN CORRIDORS

There are 194 miles of stream channels in the Project Area (Table 7). 27% (52 miles) of the channels have perennial flow and are fish bearing (Category 1). 16% (31 miles) of the channels have perennial flow and are not fish bearing (Category 2). The 57% (111 miles) are intermittent (Category 4). Very few streams in the project area are named. Therefore, for analysis and reference purposes, those streams that did not have a name were given identifiers in the GIS attribute tables (USDA Forest Service, GIS 2018 Database).

Over the last number of years (2008 to 2015), stream surveys were conducted on many of the fish bearing Category 1 streams in the Project area using the Region 6 Stream Survey methodology. Additional data was gathered from Proper Functioning Assessments and cross section analyses. Data collected were bankfull widths, wetted widths and depths, stream gradients, and channel sinuosity (Table 22).

Table 7. Summary of streamflow by subwatershed within the Project Area.

Project Area (sq. miles)	Stream Flow	Total Stream Miles
Headwaters North Fork Burnt River		
20.4	Category 1	19.3

	Category 2	11.7
	Category 4	26.5
	TOTAL	57.5
Patrick Creek-North Fork Burnt River		
12.7	Category 1	1.6
	Category 2	4.6
	Category 4	19
	TOTAL	25.2
Petticoat Creek-North Fork Burnt River		
14.2	Category 1	13.9
	Category 2	0.06
	Category 4	27.9
	TOTAL	41.8
Camp Creek		
26.7	Category 1	16.6
	Category 2	15
	Category 4	35.1
	TOTAL	66.7
Antelope Creek		
1.4	Category 1	0
	Category 2	0
	Category 4	3.03
	TOTAL	3.03
Trout Creek		
0.1	Category 1	0.1
	Category 2	0
	Category 4	0

Stream-side vegetation varies, but for Category 1 streams it is shrub- and tree-cover dominated with forbs and grasses in the understory. Present are aspen/common snowberry, mountain alder-red osier dogwood/mesic forbs, mountain alder/snowberry as well as channels with only conifers. Where riparian vegetation is present, the majority of the widths were less than 25 feet wide (stream survey field sheets for Patrick Vegetation streams, project file). Category 4 stream riparian areas exhibit limited hardwood cover and dominated by conifers due to fire suppression.

Channel morphology

Most of the forested streams in the project area are Rosgen A and B type streams (Rosgen 1996). They are relatively confined, have low sinuosity, and flow through narrow drainages bordered by steep, forested hillslopes. These drainages are typically a step-pool system and therefore, potential changes in channel morphology are limited to changes in channel widths and depths and step-pool characteristics and frequencies. The channel widths and depths are in part the result of historic land use and current flows and therefore are oversized for the drainage areas and flows. Most meadows within the project boundaries are few as they are typically privately held and managed. See Fisheries report for rosgen stream types in fish bearing portions of the stream network.

Bank and Bed Stability

The RMO for Bank Stability is greater than 80% stable in non-forested systems (USDA Forest Service 1995a). The RMO for Lower bank Angle in non-forested systems is greater than 75 percent of banks with less than 90 degree angle (i.e. undercut) (USDA Forest Service 1995a).

Channel stability is evaluated in this report as the potential for channel widths and/or depths to increase. The type and abundance of bank vegetation plays an important role in determining bank cohesion and resistance to erosion. Dense riparian vegetation decreases the potential for channel straightening by increasing bank and floodplain cohesion and limiting the ability of the stream during high flows to cut a new channel on the floodplain. The roots of riparian vegetation and conifers both increase channel bed stability as does the presence of cobbles and boulders.

Bank stability was evaluated for two areas: 1) the portion above bankfull, and 2) the bed portion below bankfull. Channel bed stability was based on the presence of absence of headcuts. Headcuts may occur as a result of channel straightening or a change in base level downstream that triggers a headcut. The 2010 to 2015 stream surveys provided information on bank stability for the portion of bank above the bankfull stream margin using the following definition:

“Bank stability is a measure of actively eroding banks at an elevation above the bankfull stream margin. That is, naked substrate within the bankfull channel is the normal condition due to the dynamic nature of the bankfull channel and is not necessarily an indication of eroding banks. An eroding bank is characterized by any one or a combination of the following factors provided they occur at an elevation above the bankfull flow: bare exposed colluvial or alluvial substrates, exposed mineral soil, evidence of tension cracks, or active sloughing. A bank that is composed of only cobbles and gravels may, nonetheless, be stable; the sand, silt and clay components no longer present in a naked bank may be quite resistant to erosion. If there is no sloughed material perched atop the lower banks, do not consider a naked bank unstable...” (USDA Forest Service 2010).

Based on this definition, greater than 80 percent of the banks above the bankfull stream margin were found to be stable (Table 8).

Table 8. Bank stability ratings by stream reach.

Stream Reach	Right Bank Percent Stable	Left Bank Percent Stable
Camp Creek 1	92	92
Camp Creek 2	94	93
Mosquito Creek 1	99	94
Mosquito Creek 2	99	99
North Fork Burnt River 2	80	85
North Fork Burnt River 3	80	88

Stream Reach	Right Bank Percent Stable	Left Bank Percent Stable
North Fork Burnt River 4	86	98

With respect to channel bed stability, headcuts, due to a base level change, are the dominant way bed stability decreases and channel incise because sinuosity is already low (1.2 or less) within the Patrick Vegetation project area. While headcuts do exist in some of the streams, large portions of their length appear stable.

Wetted Width/Depth Ratios

The RMO width/depth ratio is Wetted width/Average Depth ratio. The RMO is less than 10, mean wetted width divided by the mean depth (USDA Forest Service 1995a).

The wetted width and depth information summarized in the 2018 Forest Service GIS data for the streams is presented in Table 22. Average wetted widths ranged from 1.62 to 34.18 feet. The average pool depths were less than 4.1 feet. Average width/depth (W/D) ratios range from 1.81 to 28.48

Of the 49 W/D ratios, 13 were 5 or less; 44 were less than 10; and 5 were over 10. This indicates that W/D ratios less than 10 exist and likely reflect a desired condition, along with a much smaller range in the variability.

Channel Complexity (inchannel wood, debris jams, and pools)

Inchannel Wood and Debris Jams

The RMO for Large Woody Debris for east of the Cascade Crest in Oregon, is greater than 20 pieces per mile; greater 12 inch diameter; and greater than 35 foot length (USDA Forest Service 1995a).

Wood adds complexity to stream channels. It can create sediment storage zones and assist in the development of pools, provide fish hiding cover, and amphibian and macro invertebrate habitat (Jackson and Sturm 2002; Hassan et al. 2005). Throughout the various stream survey that have been conducted within the Project Area over the past number of years and for wood in small streams to be counted, the piece had to be 1) greater than 6 inches when measured at a distance from the large end at twice bankfull width of the habitat unit (USDA Forest Service 2010) and 2) interact with the bankfull channel.

Sources of wood input include processes of wind throw, insect and disease outbreaks, timber harvesting, mass wasting processes, fire, and tree mortality (Hassan et al. 2005). However, natural inputs of conifers in the project area are low because 1) conifers typically have long life spans (> 250, up to 900 years), 2) mass wasting is typically rare in the project area and 3) wildfires have been suppressed. Cottonwoods and aspen occur along portions of the streams. The typical life spans of aspen and black cottonwood are 80 to 100 years and 100 to 200 years respectively (USDA Forest Service 2014b). Therefore, inputs from these two species, where present, are expected to be more frequent. Dogwood and alder are also present. These two species also potentially contribute wood to the channel. Though of a smaller size, they will indeed contribute to the development of debris jams.

The majority of the streams surveyed within the project area are not meeting the RMO for large woody debris (Table 22). The streams not meeting the RMO include Geiser Creek, North Fork of Burnt River,

portions of Snow Creek, Patrick Creek, Mosquito Creek, Camp Creek, most of Gimlet Creek, and Pinus Creek. Portions of Snow, Camp and Gimlet Creeks, as well as Cub Creek and Greenhorn Creek, are meeting the RMO for large woody debris. Gimlet and Cub Creeks underwent salvage harvests in 1985 and 1993 respectively post fire. The fire and salvage activities may have led to large woody debris by leaving dead trees to fall within the RHCA. These trees contributed large woody debris Gimlet and Cub Creeks which helped these streams meet the RMO for large woody debris.

Pool Frequency

The RMO for Pool Frequencies varies by channel width (Table 9). The wetted width (feet) correlates to pools per mile (USDA Forest Service 1995a).

Table 9. RMO objectives for pool frequency.

Wetted widths (feet)	10	20	25	50	75	100	125	150
Pools per mile	96	56	47	26	23	18	14	12

Pools in the forested portion of the project area tend to have a step-pool morphology. Pools per mile varied from 2.3 to 48.28. The percent of pool habitat varied between 0 to 8.5%. Pool frequency was highest on Mosquito Creek (48 pools/mile). Pool frequencies on Camp and Pinus Creeks were both lower suggesting room for improvement (Table 22). Based on information from stream surveys, it is expected that pool formation in the other streams in the project area is also low. Given the site conditions, wood is expected to be the dominant component in pool development.

Stream Sedimentation

The RMO for fine sediment is <20% in spawning habitat, with fine sediment defined as <2mm. The Oregon DEQ (ODEQ) has established water quality standards necessary to meet Clean Water Act (CWA) requirements in order to assure protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife. Two streams (North Fork Burnt River and Trout Creek) and three watersheds (Headwaters North Fork Burnt River, Patrick Creek – North Fork Burnt River, and Trout Creek) within the Project Area are 303(d) listed for sedimentation. ODEQ listed these for sedimentation because of what the USFS stated in the 1995 North Fork Burnt River Watershed Analysis. The Watershed Analysis states that stream habitat is below potential for supporting fish due to high cobble embeddedness. More current information sediment data is available for Patrick Creek in Table 10 and illustrates a high percentage of streambed materials composed of sand, silt or clay and are less than 2 mm in size class.

Approximately 566 acres of the Trout Creek subwatershed and approximately 639 feet of Trout Creek are located within the project area and the remainder of stream is outside the project area. There are no proposed actions within the Trout Creek Riparian Habitat Conservation Area (RHCA). Since it is a small portion of the stream in the project area and no proposed actions are occurring along this portion of the stream, Trout Creek is not carried forward further in the analysis on sediment.

Two Wolman Pebble Counts were done from 2007-2018 for each surveyed reach, except for North Fork Burnt River Reach 4. Values for both counts are provided (Table 10). The first number in each column belongs to the first count. The percentages of channel substrate less than 2 mm ranged from 0 to 82% with an average value of 28. The variability of fines across the streams is quite large. Three sites had both of the fine sediment values >20% that were over the forest plan standard. Five sites had both measurements <20% and six sites were mixed with values above and below the threshold. Sources of the fines are likely roads, eroding or trampled stream banks, and trampled seeps/springs adjacent to the streams.

Table 10. Channel substrate for stream survey reaches.

Stream	Reach	Year	Sand, silt, clay (< 2mm) ¹	Gravel (2 to 64 mm) ¹	Cobbles (64 to 256 mm) ¹	Boulders (256 to 512 mm) ¹
Camp Creek	R1	2012	35/49	49/51	16/0	0/0
	R2	2012	13/16	33/77	4/7	0/0
Gimlet Creek	R1	2018	18/28	83/71	0/1	0/0
	R3	2018	8/25	83/62	10/12	0/1
Mosquito Creek	R1	2013	3/59	95/41	2/0	0/0
	R2	2013	70/10	19/77	11/6	0/8
Patrick Creek	R2	2018	45/82	18/7	40/0	0/7
North Fork Burnt River	R1	2007	0/3	58/68	42/29	0/0
	R2	2016	21/10	54/72	24/19	0/0
	R3	2016	24/35	67/45	9/11	0/3
	R3	2007	1/3	60/68	33/28	5/2
	R4	2016	17	71	6	3
	R4	2007	12/6	64/70	20/22	2/1
	R5	2007	26/7	48/77	24/11	2/5

1. Represents the percent contribution of sediment class compared to total grain size distribution

Potential sediment inputs from roads tend to occur during storm events. When this occurs, there are short-term increases in turbidity levels and decreased water quality. When roads contribute sediment during storm events, the sediment enters at points. Silt and clays move through as suspended load resulting in short-term increases in turbidity. Sand size particles settle out as flow drop. Potential sediment inputs from the stream banks and seeps occur during high flow events and as a result of bank trampling. Inputs during high flow events tend to move through the system.

Sediment Inputs from Roads

Sediment inputs from roads typically occur during storm events. Primary factors contribute to the amount and duration of sedimentation, factors like storm duration, the make-up of their construction, density of roads within the watershed, and the substrate that they are built upon. Roads tend to change the ability of a drainage basin's ability to absorb water into the soil profile. When this occurs, there are short-term increases in turbidity levels and decreased water quality throughout the drainage and stream system. When roads contribute sediment during storm events, the sediment usually enters at specific points in the system. Silt and clays move through as suspended load resulting in short-term increases in turbidity. Sand size particles settle out as instream energies decrease to levels incapable of maintaining them.

Factors such as road surface type (bare ground, grass, gravel, aggregate), soil texture, level of use (none, light, heavy), slope (lateral and linear), and maintenance determine the amount of sediment generated. In turn, the effectiveness of the drainage features, buffer distance between road and stream, and road gradient influence the potential for sediment to be transported and delivered to the stream (Swift 1984). Road surfaces composed of grass or gravel decrease the amount of road surface that is eroded by traffic use or precipitation events and limits the development of ruts that can transport water and sediment to a stream compared to native surface roads as the hydrologic energies on the former tend to be offset by the nature of the material. Open roads have more sediment generated compared to closed roads because of

the increased traffic use (Swift 1984); where increases in sediment production caused by traffic were found to persist after traffic ceased.

Information on project area roads, road/stream crossings and road surface types was used to assess potential for sediment inputs into streams. More than 90% of the road drainage features on the open roads are in need of maintenance as they are clogged with debris, collapsed or filled with rock and native substrate (Rabe Consulting 2018). Of the 447 crossings that occurred on open roads, 119 occur on aggregate or asphalt surface roads compared to the closed roads in which of the 40 crossings, 40 occur on native surface roads.

Nearly all of the crossings on the closed roads occur on native surface roads. However, the limited use of these roads has allowed the development of either vegetated or an armored surface. The stable surfaces, combined with minimal traffic, limits sediment generation and thus the potential for sediment to be delivered to streams at road/stream crossing points on closed roads (Table 11).

Table 11. Number of road/stream crossings by subwatershed, road surface type and road status.

Subwatershed	Open Roads			Closed roads	
	Asphalt	Aggregate	Native	Aggregate	Native
Headwaters North Fork Burnt River	0	29	101	0	13
Patrick Creek-North Fork Burnt River	3	14	26	0	4
Petticoat Creek -North Fork Burnt River	0	53	64	0	12
Camp Creek	1	17	127	0	7
Trout Creek	0	0	0	0	0
Antelope Creek-North Fork Burnt River	0	2	10	0	4
TOTAL	4	115	328	0	40

Stream Flow

Stream flows in the project area are characteristic of a snowmelt hydrograph. Peak flows usually occur in late March or early April in response to snowmelt and then decrease to summer low flows. By late June to early July streams are either dry or flow only as a result of groundwater inputs. Perennial streams in the Project Area are Gimlet Creek, China Creek, Camp Creek, Cub Creek, North Fork Burnt River, Geiser Creek, Sheep Creek, Mosquito Creek, Pinus Creek, Patrick Creek, and a couple of unnamed small tributaries.

Stream flows were measured on North Fork of Burnt River with a gaging station (Station ID #13269450) and provide an example of hydrograph shapes (Figure 3). North Fork of Burnt River is the largest stream in the project area. The river has relatively low base flows with high peak flows during spring snowmelt runoff and spring and early summer rain events.

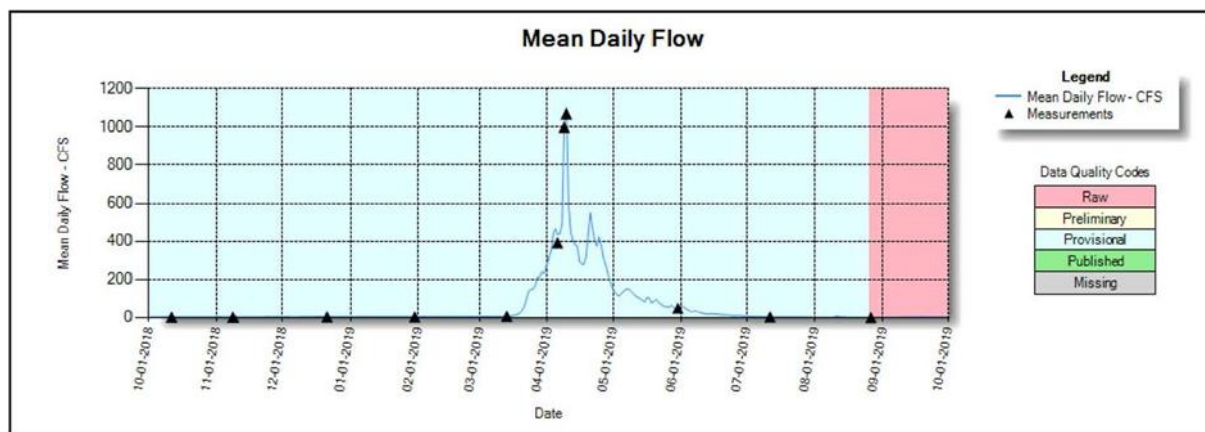


Figure 3. Hydrograph for North Fork of Burnt River (OWRD 2019a)

The assumptions for this analysis are that stream flows are departed in the Patrick Project Area from historic conditions. The project area had many historical impacts that are illustrated in the stream flow hydrograph. Some of those actions include beaver trapping, wood removal from streams and from wood recruitment zones (forested riparian area), mining, stream channel straightening, road construction, fire suppression and past timber management. Impacts to the hydrograph include an increase peak discharge (in Figure 3 as about 1,100 cfs), a rapid falling limb of the hydrograph and then lower baseflows during the summer months. Increased storage of water would be present and would positively impact water temperatures if these historical impacts were reversed.

Channel Shade

Liquori and Jackson (2001) found in their study of headwater streams that stream temperatures in scrub-shrub channels were lower when compared to adjacent reaches of forested channels. Light intensity levels for the scrub-shrub channels were up to three to four times lower than in adjacent forested channels. The effectiveness of riparian shrubs and scrub (i.e. here; alders, dogwood, and willows) in providing dense stream-side shade is a function of both abundance and size of the stream. The narrower the stream, the more influence the vegetation has upon the associated stream itself, directly. The effectiveness in riparian woody plants and steep hillslopes in shading the full width of headwater streams and contributing to microclimates that are unique to headwater streams was also noted by Anderson et al. (2007)

In the project area, streams are typically narrow (wetted widths 1 to 10 feet) making the site potential for vegetation to cast shade across the entire width, with the exceptions of the wider North Fork of Burnt River. Due to past fire suppression activities and mining, the site potential riparian vegetation has been replaced with conifers along many of the smaller streams. The conifers do not provide the dense shading which would occur with riparian vegetation which are typically dense close to the stream and not just an overstory. This riparian vegetation includes: riparian trees (i.e. aspen/cottonwood/water birch), and riparian shrubs (dogwood, alder).

The vegetation type and mix vary between drainages (stream survey field sheets in Patrick Vegetation project file). In some drainages with very intermittent flow, only conifers provide the shade. Topography is also a primary contribution to shading as a number of the drainages are bordered by steep east and west facing hillslopes. The field surveys note that individual shrubs are resprouting and there is little middle-aged riparian shrub cover. The field surveys further note that there is a site potential for riparian shrub and tree cover along the streams surveyed, and therefore presumably throughout the Project Area.

Stream Temperature

The RMO for Water Temperature is that there is no measurable increase in maximum water temperature (7-day moving average of daily maximum temperature measured as the average of the maximum daily temperature of the warmest consecutive 7-day period). Maximum water temperatures below 59°F within adult holding habitat and below 48°F within spawning and rearing habitats (USDA Forest Service 1995a).

Stream temperatures are influenced by air temperatures, shade, discharge, aspect, groundwater inputs (seeps, springs, and hyporheic flow), water depths and widths. The CWA (1977) requires states to identify those waters within its boundaries with effluent limitations. Effluent limitations are pollution limitations which are designed to limit the quantities, discharge rates, and concentrations of pollutants that are discharged. ODEQ has established water quality standards and updates their Section 303(d) list, for water quality impaired streams, necessary to meet CWA requirements in order to assure protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife. ODEQ water quality standard for temperature is based on the maximum 7-day running average. Temperature standards were developed based on temperature requirements of salmonids during different seasons and life stages. The temperature standard applicable to streams in the Patrick Vegetation project area is that water bodies must not be warmer than 68°F for use by redband trout.

There are two streams (North Fork Burnt River from Dry Creek to Unity Reservoir and Trout Creek) and four watersheds (Patrick Creek – North Fork Burnt River, Camp Creek, Trout Creek and Antelope Creek – North Fork Burnt River) listed for temperature impaired 303(d) listed streams within the Project Area according to the ODEQ database (ODEQ, 2021).

Approximately 566 acres of the Trout Creek subwatershed and approximately 639 feet of Trout Creek are located within the project area and the remainder of stream is outside the project area. There are no proposed actions within the Trout Creek Riparian Habitat Conservation Area (RHCA). Since it is a small portion of the stream in the project area and no proposed actions are occurring along this portion of the stream, Trout Creek is not carried forward further in the analysis on temperature.

Stream temperatures were collected on Geiser Creek, Greenhorn Creek, Snow Creek, North Fork Burnt River, Trout Creek and Camp Creek over the course of several years (Table 12). Many of the spot measurements exceed 68°F on the days measured and their shallow water depths (1 to 4 inches) as well as their low flows make these streams highly sensitive to air temperature. Stream temperatures are below the 68°F during portions of the year but exceed the 68°F during some portion of the summer months given that the mean maximum monthly air temperatures are greater than 80°F in July and August (Table 12). The presence of seeps or springs along a stream may be creating localized pockets of cooler temperatures but cannot be expected to be providing sufficient volumes, in and of themselves to keep stream temperatures below 68°F. Therefore, the stream temperatures are not all meeting the RMO.

Those streams not meeting the RMO for temperature based on stream temperature data (Table 12) include Geiser Creek, North Fork of Burnt River, Trout Creek and Camp Creek. Based on the stream temperature data, Snow Creek and Greenhorn Creek are meeting the RMO for temperature.

According to the Oregon Water Resource Department database (OWRD 2019b), there are water rights within the project area and encompassed private property for beneficial uses included irrigation, mining, livestock water, wildlife water, and fire protection. The Forest Service holds the water rights for all of the livestock water, wildlife water and fire protection water rights within the project area. These rights are each less than 0.01 cfs.

In contrast the water rights for mining are much larger, with the four largest are 10 cfs or greater (10 cfs from Camp Creek, 10 cfs from Pine Creek, 25 cfs from North Fork of Burnt River, and 22 cfs from Bennett Creek). All of the mining water rights are from the North Fork of Burnt River or its tributaries. All of the irrigation water rights divert from the North Fork of Burnt River with the largest being 7.11 cfs. These water withdrawals, particularly those occurring during the warmer summer months, contribute to the warmer stream temperatures in the North Fork of Burnt River. Snow Creek and Greenhorn Creek do not have water rights for water withdrawals. Not having water diversions may contribute to the cooler stream temperatures found in these streams.

Table 12. Spot stream temperatures from stream survey.

Creek	Reach	Dates	Temperature Ranges (*F)	Type of data collection
Geiser Creek	Geiser 83G.1	06/02/1995 to 09/02/1995	54.34 to 61.30	Variable locations along stream
	Geiser 83G.2	06/15/1997 to 09/05/1997	53.70 to 60.81	
	Geiser 83G.4	07/02/2008 to 10/12/2008	40.97 to 69.02	
Greenhorn Creek	83G.1	07/03/2008 to 10/16/2008	37.20 to 64.91	
North Fork Burnt River	NFBR 83A.1	06/16/2017 to 10/03/2017	38.18 to 80.27	
	NFBR 83C 1.4	06/16/2017 to 10/03/2017	40.39 to 81.02	
	NFBR 83E.2	06/16/2017 to 10/05/2017	41.28 to 82.71	
	NFBR 83E.3	06/15/1997 to 10/02/2017	37.56 to 78.95	
	NFBR 83G.4	06/24/2012 to 10/13/2012	33.19 to 69.31	
	NFBR 83xxx.5	06/21/1999 to 10/04/1999	50.59 to 76.20	
	NFBR 83E.6	06/21/1999 to 10/04/1999	51.92 to 73.58	
Snow Creek	Snow 83G.1	05/19/2012 to 10/09/2012	40.76 to 63.36	
	Snow 83G.2	06/15/1997 to 09/05/1997	54.22 to 61.55	
Trout Creek	Trout 83D.1	07/20/2005 to 09/05/2005	68.08 to 76.97	Hobo. Fixed Location

Creek	Reach	Dates	Temperature Ranges (°F)	Type of data collection
Camp Creek	Camp 83F.1	06/17/2017 to 10/17/2017	39.08 to 66.43	Spot measurements. Variable locations along stream
	Camp 83F.2	06/16/2017 to 10/03/2017	37.04 to 76.55	
	Camp 83F.3	06/16/2017 to 10/06/2017	36.27 to 75.16	
	Camp 83F.4	06/16/2017 to 10/06/2017	41.31 to 65.18	

Seeps/Springs

Streams in the project area are small with average wetted widths less than 3.2 feet and average water depths less than 4 inches (Table 22). While temperatures were not measured at these locations, the role of seeps and springs in locally reducing stream temperatures and contributing to summer base flows has been noted by Meays et al. (2005) and Boulton and Hancock (2006). Further, inputs from seeps and springs are suggested as providing thermal refugia for both fish and macro invertebrates (Ebersole et al. 2001, 2003). Literature shows that where seeps and/or springs are abundant along a stream, they can increase stream flows and, at least locally, reduce stream temperatures. Inputs from tributaries are also contributing factor to decreased downstream temperatures if and when they add cooler water (Meays et al. 2005).

Other Water Quality

The North Fork of Burnt River is 303(d) listed for pH and dissolved oxygen. Although this is considered a water quality impairment, it is tied to the legacy mining activities. Therefore, the discussion of pH and dissolved oxygen water quality impairment will no longer be brought forward into the analysis because it is not relevant to the Proposed Action.

Floodplains and Wetlands

Floodplains and wetlands are present in the project area and were evaluated in the context of compliance with Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands). Active floodplains are less than about 25 to 30 feet wide per side either because the stream flows is bordered by steep slopes or because the stream has become entrenched. Many of the active floodplains exhibit legacy impacts from eradicating all beaver before 1850, promoting riparian areas as sacrifice areas for livestock management up to 1970s, removing wood from streams with logging practices and mining activities. With the development of the Forest Plan (USDA Forest Service 1990), best management practices and INFISH, these practices have changed and improved the way floodplains and wetlands are managed.

Executive Order 11988 (Floodplains Management) requires government agencies to take actions that reduce the risk of loss due to floods, to minimize the impact of floods on human health and welfare, and to restore and preserve the natural and beneficial values served by floodplains. Executive Order 11988 defines the term “floodplain” as follows: “...that area subject to a one percent or greater change of flooding in any given year.”

Executive Order 11990 (Protection of Wetlands) requires government agencies to take actions that “avoid to the extent possible the long and short term adverse impacts associated with the destruction or

modification of wetlands.” Executive Order 11990 (Sec 2 (a)(1 and 2) further states “shall avoid undertaking or providing assistance for new construction located in wetlands unless the head of the agency finds (1) that there is no practicable alternative to such constructions, and (2) that the proposed action includes all practicable measures to minimize harm to wetlands which may result from such use...” Executive Order 11990 defines wetlands and new construction as follows:

Wetlands: The term "wetlands" means those areas that are inundated by surface or ground water with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds.

New construction: The term "new construction" shall include draining, dredging, channelizing, filling, diking, impounding, and related activities and any structures or facilities begun or authorized after the effective date of this Order.

INFISH Riparian Goals

“The Riparian Goals establish an expectation of the characteristics of healthy, functional watersheds, riparian areas and associated fish habitats. Since the quality of water and fish habitat in aquatic systems is inseparably related to the integrity of upland and riparian areas within the watersheds, the strategy [INFISH] identifies several goals for watershed, riparian, and stream channel conditions” (USDA Forest Service 1995a). The riparian goals that apply to the Patrick Vegetation Project Area are listed in Table 13 and how well those goals are currently being met.

Table 13. INFISH Riparian Goals that apply to the project area and existing condition.

Riparian Goal No.	Description	Existing condition
RG- 1	Maintain or restore water quality, to a degree that provides for stable and productive riparian and aquatic ecosystems	Conifer encroachment is impeding the expansion of aspen and riparian vegetation. Legacy impacts from mining, historic trapping of beaver, and fire suppression has contributed to conifer encroachment. Additionally water withdrawals within the project area from streams for irrigation and mining are impacting water quality through decreased flows which may lead to increased water temperatures.

Riparian Goal No.	Description	Existing condition
RG-2	Maintain or restore stream channel integrity, channel processes, and the sediment regime (including the elements of timing, volume, and character of sediment input and transport) under which the riparian and aquatic ecosystems developed.	Conifer encroachment is displacing well rooted riparian vegetation, contributing sediment inputs into the creek and decreasing stream bank stability. In addition, if high severity wildfire occurred, RG-2 would not be met because increased soil erosion and inputs into the stream channels post wildfire would degrade water quality and contribute to channel erosion and a loss of channel integrity. These effects represent a change in the sediment regime under which these stream systems developed.
RG-3	Maintain or restore instream flows to support healthy riparian and aquatic habitats, the stability and effective function of stream channels, and the ability to route flood discharges.	Conifer encroachment (including juniper) is reducing surface flows, due to the high rate of evapotranspiration and outcompeting other riparian vegetation which could stabilize the stream channels and route flood discharges. Conifer encroachment is impeding the expansion of aspen and riparian vegetation, thereby altering the natural runoff timing by not delaying runoff through infiltration and surface roughness.
RG-4	Maintain and restore natural timing and variability of the water table elevation in meadows and wetlands.	Conifer encroachment is impeding the expansion of aspen and riparian vegetation, thereby altering the natural runoff timing by not delaying runoff through infiltration and surface roughness.
RG-5	Maintain or restore diversity and productivity of native and desired non-native plant communities in riparian zones.	Conifer encroachment is impeding the expansion of aspen and riparian vegetation, thereby decreasing riparian vegetation diversity.
RG-6	Maintain or restore riparian vegetation to: (a) provide a natural amount of large woody debris characteristic of the aquatic and riparian ecosystem; (b) provide adequate summer and winter thermal regulation within the riparian and aquatic zones; and c) help achieve rates of surface erosion, bank erosion, and channel migration characteristic of the natural system.	(a) Current conifers are young and inputs are expected to be slow unless a wildfire were to occur and create a large amount of standing dead wood or if conifer mortality occurs do to an insect or disease infestation. This material would be a source of future wood inputs though the timing of would inputs is unknown. Currently aspen and riparian woody plants are being replaced with conifers through encroachment. This pressure reduces riparian vegetation and does not allow for riparian vegetation expansion to a site potential extent. This limits the ability of woody riparian vegetation to contribute to inchannel wood limited. Existing conifers are young and their inputs are expected to be low and infrequent. (b) Dense, stream side riparian shade is limited (conifers only provide overstory shading) and conifer encroachment are preventing riparian woody plants from expanding in places. (c) Conifer displacement of well rooted riparian vegetation is occurring.

Riparian Goal No.	Description	Existing condition
RG-8	Maintain or restore habitat to support populations of well-distributed native and desired non-native plant, vertebrate, and invertebrate populations that contribute to the viability of riparian dependent communities.	Conifer encroachment is impeding the expansion of riparian vegetation and aspen suckering. Riparian vegetation is limited in the project area and therefore the diversity needed to contribute to the viability of riparian dependent communities is also limited.

RIPARIAN HABITAT CONSERVATION AREAS (RHCA)

RHCAs are portions of watershed where riparian-dependent resources receive primary emphasis and management activities are subject to specific standards and guidelines. RHCAs include traditional riparian corridors, wetlands, intermittent streams and other areas that help maintain the integrity of aquatic ecosystems by (1) influencing the delivery of coarse sediment, organic matter, and woody debris to streams, (2) providing root strength for channel stability, (3) shading the stream, and (4) protecting water quality (USDA Forest Service/USDI 1995a, p A4).

The RHCA widths vary from 50 to 300 feet per side depending on fish presence and stream flow (Table 14). The majority of the RHCAs consist of upland vegetation with the riparian vegetation zone limited to 0 to 25 feet wide per side. The reason for the limited width of the actual riparian vegetation zone in comparison to the total RHCA width varies. In places it is because the streams are confined between steep hillslopes. In other places distributed across the Project Area, riparian vegetation is restricted due to conifer encroachment into these areas and/or browse pressure.

Table 14. INFISH RHCA Stream Categories

Category	Description	RCHA width
1	Fish-bearing stream (perennial or intermittent flow)	300 feet/side
2	Perennial and non-fish bearing	150 feet/side
3	Ponds, lakes, reservoirs, and wetlands great than 1 acre	150 feet/side
4	Seasonally flowing or intermittent streams, wetlands less than 1 acre, landslides, and landslide-prone areas	50 feet/side in the project area

Flexibility in the width of the RHCAs, or entrance into an RHCA, is permitted in INFISH (see below) provided that the goals if INFISH are considered and the affect to fish must be negligible or no effect. The goals are to “achieve a high level of habitat diversity and complexity through a combination of habitat features, to meet the life history requirements of the fish community inhabiting a watershed (USDA Forest Service/USDI 1995a, A-3).”

Adoption of these requirements [INFISH] during the interim period is not to be considered a “lockout” of any project of activity from the RHCAs. However, proper analysis is required prior to initiation of projects (USDA Forest Service/USDI 1995a, A-1).

Interim RHCA widths would apply where watershed analysis has not been completed. Site-specific widths may be increased where necessary to achieve riparian management goals and objectives, or decreased where interim widths are not needed to 1) attain RMOs or 2) avoid adverse effects (emphasis added) (USDA Forest Service/USDI 1995a, A-5)

Site-specific analysis were done for each of the units that entered into an RHCA as required by INFISH (project file Appendix PF-4). The site-specific analysis ensures that streams are protected from both channelized and non-channelized sediment inputs and that other riparian functions, including delivery of organic matter and woody debris, stream shading, and bank stability, and diversity are enhanced (USDA Forest Service/USDI, 1995a). The rationale for modifying RMOs was presented earlier in this document under the appropriate header.

INFISH Riparian Management Objectives (RMOs)

The Fisheries Report for this project provides analysis of 3rd through 6th order streams as they pertain to the RMOs.

Table 15. Compliance with the Riparian Management Objectives

Habitat Feature	Objectives	Summary
Pool Frequency (sf□) (all systems)	Varies by channel width. See discussion under Pool Frequency for details.	The surveyed stream reaches were deficient in pools, due to a lack of large woody debris. Based on field observations, other streams in the project are expected to also be deficient in pools.
Water Temperature (sf²)	No measurable increase in maximum water temperature. Compliance with state water quality standards, or maximum <68°F	Stream temperatures on Geiser Creek, North Fork of Burnt River, Trout Creek and Camp Creek exceed this standard. There are two streams (North Fork Burnt River from Dry Creek to Unity Reservoir and Trout Creek) and four watersheds (Patrick Creek – North Fork Burnt River, Camp Creek, Trout Creek and Antelope Creek – North Fork Burnt River) that are considered 303(d) listed for temperature. Based on the shallow water depths and low flows, other streams in the project are expected to exceed the temperature standard for a portion of the summer. This is due to a lack of dense riparian vegetation, caused by conifer encroachment.
Large Woody Debris (sf) Forested systems	>20 pieces per mile, ≥12 inches diameter, and >35 ft length.	Most streams in the project area are deficient in LWD for some or all of their length based on field observation, with the exception of Greenhorn Creek, Cub Creek, Snow Creek and Gimlet Creek. Streams not meeting the RMO include Geiser Creek, North Fork of Burnt River, portions of Snow Creek, Patrick Creek, Mosquito Creek, Camp Creek, most of Gimlet Creek, and Pinus Creek
Bank Stability (sf) (non-forested systems)	>80 percent stable	N/A. This RMO applies to non-forested system. Most of the project area streams flow through forested areas. Data for streams in Project Area show streams exceed 80% stable.
Lower Bank Angle (sf) (non-forested systems)	>75% of banks with >90 degree angle (i.e. undercut)	N/A. This RMO applies to non-forested system and most of the project area streams flow through forested areas.
Width/Depth Ratio (sf) (all systems)	<10, mean wetted width divided by mean depth	W/D ratios do not exceed this RMO value in most streams surveyed in 2010. Average values ranged from 1.62 to 34.18 but were highly variable. Most streams in the Project Area (44 out of 49) were less than 10. Other perennial streams in the project are

Habitat Feature	Objectives	Summary
		also expected to be attaining this RMO in their W/D ratios.
Substrate	Fine sediment: <20% in spawning habitat. Fine sediment defined as <2mm	Two streams (North Fork Burnt River and Trout Creek) and three watersheds (Headwaters North Fork Burnt River, Patrick Creek – North Fork Burnt River, and Trout Creek) are 303(d) listed for sedimentation.

ENVIRONMENTAL CONSEQUENCE

Environmental consequences of the proposed actions were evaluated by examining the direct, indirect, and cumulative effects of both alternatives upon water resources. A direct effect is defined within this report as an effect that would occur immediately (e.g. loss of shade) or within one to two years (e.g. sediment contribution from roads.).

An indirect effect is defined as an effect that would occur five or more years later; either at the site or downstream from the actual action and yet, still a direct consequence to the action. Examples are:

- 1) The decomposition of tree roots along the stream bank as a result of logging; and
- 2) An increase in shade as a result of increased riparian shrubs.

Cumulative effects occur when the effects of the proposed activity overlaps in time and space with the effects of various past, present or reasonably foreseeable future activities in the project area. Examples of cumulative effects would be increases in stream temperatures on a stream where temperatures are already elevated due to 1) the removal of shade on a stream because of wild ungulate and livestock browse on riparian woody plants or aspen; or 2) an increase in temperature due to channel widening due to lateral shearing during high flow events.

This effects analysis does not consider the effects of wild ungulates or livestock as direct or indirect effects. Effects of wild ungulates and livestock on water resources are covered in the cumulative effects.

There are three alternatives and all of which will be evaluated under this section to examine their potential impacts to water resources within the Project area. Alternative 1 is the No Action alternative. Alternative 2 (the Proposed Action) includes commercial thinning activities outside of RHCAs; non-commercial and pre-commercial thinning outside of RHCAs; riparian vegetation restoration treatments (RVR); RVR commercial harvest; RVR non-commercial/pre-commercial thinning; piling and burning within RVR units; and prescribed burning RVR and non-RVR units. Alternative 3 (the Proposed action with no activities in RHCAs) is similar to Alternative 2 with the following differences: no activities within the RHCAs except prescribed burning with no active lighting for prescribed burning in RHCA and general road maintenance and rehabilitation for roads that are located within an RHCA would still occur.

The potential impact to water resources of these alternatives varies as a function of: 1) the geographical extent of the activity; 2) the magnitude of change in the overstory and understory vegetation; 3) the topography; and 4) road locations and their orientations with respect to the streams. The parameters with the greatest potential for change under the proposed activities are: 1) soil water available to plants; 2) channel morphology; 3) channel complexity; 4) channel substrate; 5) stream flows; and 6) stream temperature. This effects analysis examined the alternatives with respect to their impacts on these parameters.

The tables referenced in the effects analysis are found at the end.

ALTERNATIVE 1 (NO ACTION)

Alternative 1 (No Action) would not authorize new activity in the project area. All current management activities would continue in the project area as currently authorized and permitted. Activities include wildlife and livestock grazing, recreation, woodcutting, road maintenance, and wildfire suppression.

Direct/Indirect Effects of the No Action Alternative

Soil Water Available to Plants

Under the No Action Alternative, the potential soil water available to plants for use is expected to decrease as overstory canopy cover and the number of canopy layers increase. Decreased soil water would occur because interception by branches, needles, and evaporation of rain and snow would decrease the amount reaching the ground and infiltrating. Water stress on both overstory woody plants and understory herbaceous vegetation is expected to increase.

Channel Morphology

Channel morphology in the forested portion of the project area is limited to changes in channel widths and depths as well as step-pool features. Channel morphology in the non-forested portion of the project area can adjust laterally or vertically as a pool-riffle channel type.

Bank stability is expected to continue to decline in areas lacking riparian vegetation; specifically, in those areas having limited rooted stream bank vegetation. As bank stability decreases, bank erosion potential in response to instream flows typically causes lateral shearing of the exposed soil; causing channel widening and incision. Although different soil types have various resiliencies to this, increased channel capacity and sediment laden high flows downstream are typically seen as the consequence of stream bank erosion. The result is a flashier hydrologic system favoring the decrease in the amount of water held within the drainage basin; and as applicable here, to this project area.

Channel Complexity (Large wood, debris jams, and pools)

Channel complexity is expected to remain for the most part as limited because increases in pools and debris jams throughout the project area depend upon wood inputs from both conifers and riparian woody plants adjacent to the streams. These contributions are expected to decrease due to the effects of increasing conifer shading reduces the riparian woody plants adjacent to streams, as discussed in the Silviculture Report (Cuzick 2019). Increased conifer encroachment could result in an increase in wood input from conifers. As a result, pool and debris jam development would be limited because riparian wood is the major contributor to pool formation and key large wood pieces are needed to create sites for debris jam formation.

Channel Substrate

Channel substrate is expected to continue in its current condition. Roads intermittently also contribute fine sediment during storm events. The amount of sedimentation from roads depends upon road surface material and slope, location, and drainage features. The amount and sources of sediment entering the streams would be expected to remain the same except in the case of a wildfire occurring in the project area.

Stream Flow

The magnitude, timing, pattern, and variability in stream flow would continue to vary as a function of climate, channel morphology, roads, vegetative cover, drainage-network density, and the condition of the

seep and springs that border or contribute to the streams. Stream flow conditions are expected to continue in their current conditions. This can be described as less stream flows during the summer months, because of the increased tree cover in both riparian areas and uplands.

Stream Temperature

Many of the streams in the project area would still continue to exceed the 2010 ODEQ temperature standard of 68°F. Channel width, the quality and abundance of shade cover, air temperatures, seep/spring contributions, and stream flow magnitudes all dictate stream temperatures and patterns of variability therein. Dense near channel shade is provided by riparian woody plants. Dense near channel shade is decreasing through increasing conifer encroachment, which limits the dense near channel shade's ability to shade the stream channel. Across the majority of forested streams within the project area, conifers are closing the canopy over the stream and decreasing riparian hardwoods. Impacts from tree cover and stream flow also lessen the instream water that has the potential to warm faster. Water temperatures across the project area would be expected to increase in the case of a wildfire occurring in the project area. Loss of riparian hardwoods and their seed sources could take a longer time to establish after a wildfire, if they were not already in enough cover to self-maintain following the disturbance.

Floodplains and Wetlands

No expected change from existing current conditions.

Potential Wildfire Effects Under the Alternative 1 (No Action)

Under the No Action Alternative, ladder and ground fuels would continue to persist. As a result, the risk of a large-scale, high severity wildfire in the project area would remain. Below are the potential effects that would occur to water resources if a large-scale, high severity wildfire were to occur.

Soil Water Available to Plants

Under the No Action Alternative there is an increased potential for a large-scale, high severity wildfire due to increased fuels. A large-scale, high-severity wildfire has the potential to increase surface runoff, soil erosion and stream flows during a storm event due to loss of ground cover, development of hydrophobic soils and soil sealing (Larsen et al. 2009). The magnitude of the increases would depend on the timing and magnitude of a precipitation event post fire, topography, residual ground cover and development of hydrophobic soils (Robichaud et al. 2000). While recovery of vegetation to pre-fire levels would occur about three years after a low-severity wildfire and 7 to 14 years after a moderate or high-severity wildfire respectively (Robichaud et al. 2000), hillslope and channel erosion combined with increases in channel capacity are changes. It is expected that soil erosion would result in a decrease in the available water capacity (AWC) of the project area soils.

Channel Morphology

A high severity wildfire would remove much of the finer and flashier vegetation along riparian corridors along with those of the corresponding adjacent uplands. Increased runoff and high stream flows leading to channel erosion and a loss of bank stability would be expected if a precipitation event were to occur shortly after a wildfire. Energy into the system would be regulated primarily on timing of the precipitation events and the vegetative growth patterns having the ability to control surface roughness as well as decrease erosive surface flows. Dead material left over from the fire event would be expected to contribute to in-channel morphological processes, but the timing would be unknown as to the capacity and influence throughout the project area.

Channel Complexity (inchannel wood, debris jams and pool frequency)

A high severity wildfire in the riparian area could create a large number of standing dead trees but much of the smaller diameter wood may be consumed as well as some of the inchannel wood. Over time, some of the standing dead trees would fall and provide replacement for the lost inchannel wood. However, the timing of these inputs is unknown and a loss of channel complexity could be a long term impact.

Channel Substrate

The potential for increased sediment inputs post-wildfire depends on the timing and intensity of the precipitation that may occur afterwards. If the precipitation event occurs prior to vegetative ground cover re-establishing itself, then the project area would experience increased storm runoff; soil erosion inputs of sediment could be quite high. Large pulses of an assortment of size classes of sediment are expected following a wildfire. Riparian shrubs have shallower and more fibrous root systems than deeper tap rooted conifers.

Stream Flow

The impacts on stream flows would vary depending on the severity of the wildfire and both the timing and intensity of the precipitation events post-fire. Impacts range from minimal in the absence of precipitation to that of extensive if a large precipitation event occurs immediately following a burn event (Robichaud et al. 2000). Increasing stream flows can result in increased erosion of stream banks and channel bedding.

Stream Temperatures

A high severity wildfire would effectively remove any streamside vegetation which would ultimately result in a reduction in shade to the adjacent stream. Leach and Moore (2010) modeled stream temperatures for three scenarios related to canopy cover and wildfire. They found that net radiation below standing dead trees was twice that modelled for the pre-fire canopy cover. The increase in net radiation would contribute to increased stream temperatures post wildfire. The increased solar inputs as a result of a loss of both overstory and near stream shade would increase stream temperatures, with the amount of increase depending on factors such as channel widths, topography bordering the stream, existing vegetation, and river orientation.

Cumulative Effects of the No Action Alternative

There are no cumulative effects under the No Action Alternative because there are no new activities proposed. Existing environmental trends would continue.

Floodplains and Wetlands

No expected change from current conditions.

Compliance with Executive Orders and INFISH

INFISH Riparian Goals

Under the No Action Alternative, the potential for conifer encroachment in the riparian zone and a large-scale, high intensity wildfire is expected to remain or possibly increase. Examination of the INFISH Riparian Goals relevant to the project area found that the goals of riparian habitat diversity, abundance, and productivity, sediment inputs, and thermal regulation within riparian zone would not move towards the desired condition for the project area (Table 26).

INFISH Riparian Management Objectives (RMOs)

Under the No Action Alternative, the RMOs would be the same as existing condition and trends because there would be no activity inside the RHCA (Table 15). However, over the long-term and in the event of a wildfire inside the RHCAs, stream temperatures and the amount of fines in the channel substrate would likely increase and continue to exceed the RMO values. Large wood in the channel could decrease immediately post-wildfire but would increase over time as standing dead trees fell into the streams.

Cumulative Effects of the No Action Alternative

There are no cumulative effects under the No Action Alternative because there are no new activities proposed. Existing environmental trends would continue.

ACTION ALTERNATIVES

Analysis of effects considers both the action alternatives and the Project Design Criteria that apply to those treatments (Table 19). Analysis of effects also includes the effects of the other treatments in the area where appropriate (i.e. harvest, prescribed fire, non-commercial thinning) because there are synergistic effects between these treatments and expected changes in water resource parameters. Under Alternative 3 unlike Alternative 2, there would be no treatment in the RHCAs.

Due to synergistic effects between treatments, there are expected changes in water resource parameters. PDCs are designed to address some potential effects and either minimize or eliminate water resource concerns related to the proposed treatments and maximize benefits to water resources.

ALTERNATIVE 2 (PROPOSED ACTION)

Resource Indicators and Measures

Indicators and Measures

Indicators used to analyze effects of proposed actions are listed in tables below.

Table 16. Resource indicators and measures for assessing effects to water quantity, water quality and RHCA condition

Resource Element	Sub-Element	Measure	Issue (Analysis or Key)	Source
Water Quantity	Soil Water to Plants	Canopy Cover	Analysis Issue	Wallowa Whitman NF Forest Plan
	Streamflow		Analysis Issue	Wallowa Whitman NF Forest Plan
Water Quality	Stream Temperatures	Acres of RHCA Treated, Acres of Primary Shade Zone Treated	Key Issue	INFISH, Wallowa Whitman NF Forest Plan, ODEQ 303(d)
RHCA Condition	Channel Morphology	Bank Stability, Streamflows	Analysis Issue	INFISH, Wallowa Whitman NF Forest Plan
	Channel Complexity	Debris Jams, Inchannel Wood, and Pools	Analysis Issue	INFISH, Wallowa Whitman NF Forest Plan

Resource Element	Sub-Element	Measure	Issue (Analysis or Key)	Source
	Channel Substrate	Ground Cover, Temporary Roads in RHCAs	Analysis Issue	LRMP

Direct/Indirect Effects

The direct and indirect effects of Alternative 2 will be broken into two sections: Upland Harvest Units and Riparian Vegetation Restoration (RVR) Units. The Upland Harvest Unit section will discuss direct and indirect effects in the upland areas, whereas the RVR Unit section will discuss direct and indirect effects within the riparian areas. After the discussion of the Upland Harvest Units and the RVR Units, other project components will be analyzed for direct and indirect effects.

Upland Harvest Units

Upland Harvest Units are non-RVR units for which the following activities are proposed: commercial harvest, non-commercial/pre-commercial thinning and prescribed burning. Treatments will include Group Selection (HSG), Post and Pole Thinning (PP), Defensible Fuel Profile Zone (DFPZ), Aspen Restoration Release from Conifers (Aspen REL), Post and Pole (PP) and prescribed burning (Rx Burn).

These units are discussed together because they occur primarily in the uplands and their effects on water resources are similar. They are outside the RHCAs and range from 50 (Category IV streams) to more than 300 feet from a stream (Category I streams).

Soil Water Available to Plants

Defensible Fuel Profile Zone: Thin from Below Commercial Harvest and Post and Pole (DFPZ: HTH and PCT)

Vegetation treatment in these units would decrease canopy cover and remove the lower layers of canopy cover; thus, resulting in increased precipitation reaching the forest floor, potentially increasing the available soil water. More snowmelt on the ground that infiltrates the soil may also increase the amount of water available to deeper rooted and woody vegetation that tends to favor the expression of those plants associated with riparian systems. Treatments will be selective to shift existing species composition within the units to better represent the desired Natural Range of Variation (NRV).

Thin from Below Commercial Harvest and Non-Commercial/Pre-Commercial Thin (HTH and PCT)

Vegetation treatment in these units would decrease canopy cover and decrease the lower layers of canopy cover; thus, resulting in increased precipitation reaching the forest floor, potentially increasing the available soil water. More snowmelt on the ground that infiltrates the soil may also increase the amount of water available to deeper rooted and woody vegetation that tends to favor the expression of those plants associated with riparian systems. Treatments will be selective to shift existing species composition within the units to better represent the desired Natural Range of Variation (NRV).

Aspen Restoration-Release with Thin from Below Commercial Harvest and Non-Commercial/Pre-Commercial Thin (Aspen REL)

Vegetation treatment in these units would decrease canopy cover and decrease the lower layers of canopy cover; thus resulting in increased precipitation reaching the forest floor, potentially increasing the

available soil water. More snowmelt on the ground that infiltrates the soil may also increase the amount of water available in the soil. Increased soil water availability will help promote aspen growth and regeneration in these units. Treatments will be selective to shift existing species composition within the units to better represent the desired Natural Range of Variation (NRV).

Prescribed Burning

Prescribed fire in harvest units would remove many of the trees that are less than 0.1 inch dbh and based on stand exam and LIDAR data, this size is abundant in large portions of the project area. These small seedlings are competing at least in part with understory vegetation for water in the upper 12 inches. Therefore, the removal of competing conifer seedlings, when combined with the harvest activities, would improve the amount of soil water available to plants by both increasing the amount of precipitation that reaches the ground and reducing competition for existing soil water.

Channel Morphology

There is No Effect to channel morphology because there would be no change in bank stability or increase in stream flows. Bank stability remains the same because the proposed activities are at least 50 feet from the stream channels or bounded by an existing road. The PDCs would maintain ground cover sufficient to prevent an increase in runoff during precipitation events. Therefore, there would be no increase in stream flows during storm events related to these activities. Activities under Alternative 2 are expected to result in an increase in forage production, grass and vegetative growth (Rangeland Resources Report 2019) which would further limit runoff potential by enhancing surface roughness and infiltration.

Channel Complexity (large wood, debris jams, and pools)

No direct effect to channel complexity from the proposed activities in these upland harvest units given their distance from the stream channels. Units in proximity to fish-bearing streams are approximately 300 feet from the stream. The remaining units are at least 150 feet from a perennial stream, 50 feet from an intermittent, non-fish bearing stream, or bounded by an existing road. Therefore, the potential contributions from the Alternative 2 upland harvest units to influence channel complexity via inputs of wood is already very low and no different to that of the No Action Alternative.

However, there is a potential indirect effect. Treatment activities would result in an increasing understory growth of shrubs, grasses, and forbs, with mixes varying as a function of plant associations and local environmental conditions. These woody species are potential sources of wood into the stream and are anticipated to be of the appropriate size to offer complexity to the system and slows surface flow rates encouraging both sediment deposition and pool formation.

Channel Substrate

There will be no effect to channel substrate from the proposed Alternative 2 activities for these units in the short-term (<5 years) or long-term (5 to 20 years) because the ground cover, in many cases, the existing boundary road between the units and the stream channels would effectively trap sediment and prevent its delivery to the stream channel, and in addition, the PDCs would minimize soil disturbance, bare ground, and burn severity, and therefore sediment generation. Understory shrubs, grasses and forbs are expected to increase in response to increase water and light to the ground. Monitoring of vegetation response post-prescribed fire burn found that grass, forbs, and shrubs began to re-sprout within days after a spring burn. Following a fall burn, some re-sprouting was observed in the fall with a strong vegetative response the following year. As a result, ground cover would continue to be effective in preventing erosion.

Stream Flow

Alternative 2 will have No effects on stream flows as it pertains to increased runoff related to the removal of canopy cover because the PDCs would maintain ground cover and minimize soil compaction for all of the various unit vegetation prescriptions. Both the non-commercial thinning and prescribed fire activities in the units would be of low to moderate intensity and thus: 1) ground cover would remain relatively intact; 2) soil compaction would be minimal; and 3) the activities would occur over time. As a consequence, it is therefore expected that infiltration rates within the Project would not change and that shift in ground cover type and species (from conifer dominated to shrubs, grasses, and forbs) would enhance infiltration rates and further impede runoff.

It is possible that the proposed activities could increase stream flows later into the summer as a result of the ground receiving more snow and thus more inputs of water into the soil during the spring melt. The length of this increase is unknown and would vary as a function of soil types, groundwater flow paths, snowfall and melt patterns, as well as vegetative demands on soil water.

Stream Temperatures

Alternative 2 will have no effect to stream temperatures from the vegetation prescription activities because the activities in these units would maintain adequate distance from all streams (50 feet to 300 feet). Therefore, these activities would not decrease the overall amount of shade (both short and long term) provided to the stream or decrease stream-bank stability.

Riparian Vegetation Restoration (RVR) units

Under Alternative 2 there are 481 acres of commercial activities, 4,212 acres of non or precommercial activities and 5,070 acres of prescribed fire RVR units. Some units have multiple logging systems in order to adjust for site conditions. Non-commercial thinning is proposed for all RVR units. Thinning would be by hand and would occur up to the edge of the stream channel. Prescribed fire (underburning) is proposed and pile burning would occur when a slash pile is created within the Riparian Habitat Conservation Area to reduce overall fuel loading in the area.

Soil Water Available to Plants

There would be potential increases in the amount of soil water available to plants in response to harvest and non-commercial thinning. As canopy cover in the unit would decrease, the ground cover and a portion of overstory shade would remain largely intact. Therefore, while more precipitation would reach the ground as a result of conifer removal, infiltration would occur rather than runoff. The result would be increased water into the ground and an increase in soil water available to plants, particularly to the understory shrubs, grasses and forbs.

Channel Morphology

The potential changes in channel morphology and bank stability in response to harvest, non-commercial thinning and pre-commercial thinning will be balanced. Some streambank trees may be felled that provide bank stability and the roots will remain in tact for about 5 years before they start decomposing.

Alternative 2 treatments would lead to an expansion of riparian woody plants and aspen due to more soil water and sunlight being available. This expansion of riparian woody plants and aspen would enhance bank stability and potentially channel bed stability by increasing cohesion via their root systems. Because the stability of the channel banks and beds would not change, the Width/Depth ratios would remain the same. The wetted W/D ratio would maintain existing condition because the system is sediment limited.

Channel Complexity (debris jams, inchannel wood, and pools)

Harvest and noncommercial thinning would decrease the number of trees per acre and canopy cover. The result would be an expansion of riparian woody plant and aspen and cottonwoods where site potential for these species is present. Over time, as these species expanded, there would be a shift in the type of species providing future inchannel wood. Because most of the streams are narrow (average width between 2 and 12.6 feet) and riparian woody plants and aspen are highly resilient to fire and able to resprout, these species are capable of providing wood over the long-term. Therefore, harvest and non-commercial/precommercial thinning of the conifers within the RVR units, when done in conjunction with upland harvest activities, are expected to directly and indirectly increase channel complexity.

An immediate increase in channel complexity would occur in the RVR units as a result of residual slash left in place when it is considered below acceptable fuel levels. This PDC would drop coarse wood (<10 inch diameter at bankfull) onto the valley and into the channel. For the tributary streams in the project areas, these pieces would allow for the development of debris jams as contributions from riparian woody plants and aspen entered the channel and interacted with the wood. The speed of riparian woody plants and aspen inputs into a channel would be more than under Alternative 1.

PDCs would immediately increase the amount of coarse wood material in the channel which would in time lead to increased pool frequency and the development of debris jams. Over time, increases in riparian woody plants along the stream banks would further increase near channel shade and thus decrease the rate of stream temperature increases with decreasing elevation. The increase in both riparian woody plants and aspen would provide future wood inputs and contribute to the development of both debris jams and pools.

Pool frequency is expected to increase over time as the large wood input (via residual slash and natural inputs) and debris jams create flow obstructions that lead to pool development. The timing of pool development is uncertain because it requires both flow obstructions and flows capable of scouring a pool below the obstruction.

Channel Substrate

The Alternative 2 activities would not increase percent fines into the channel substrate because of PDCs. PDCs related to skid trails and landings would minimize bare ground and the development of channelized flow. Under Alternative 2, pool frequency and channel substrate would move towards attainment in all RVR units.

Stream Flow

Conifer canopy cover would decrease as a result of the proposed harvest and non-commercial thinning. However, existing ground cover in the units is close to 100% and the PDCs would maintain ground cover and minimize the soil compaction. Studies have shown that where ground cover is 65% or greater runoff rates are minimal (Larsen et al. 2009). Therefore, increases in runoff would occur from a decrease in conifer canopy cover.

Stream Temperatures

Changes in shade, channel widths, flow, and seep/spring inputs have the potential to impact stream temperatures. The impact of the proposed treatments on these factors was examined.

No reductions in summer stream flows would occur for the reasons discussed above under Stream Flow. The condition of the seeps and springs in these units would remain in their current condition and continue to contribute cooler groundwater to the streams. The parameter of shade has the greatest potential to

change and affect stream temperatures. There are many factors that can influence shade. Aspect can influence shade with streams trending north-south being warmer than streams trending east-west. Confined valleys can have the adjacent hillslope shading the stream versus a wide valley that does not have topographic shading influences. Riparian hardwoods can provide more layers directly over the stream and can influence relative humidity and shade directly above the stream. Conifer stand age can influence the heights of the canopy and magnitude of shade. The stream gradient and channel dimensions also influence warming. The RVR treatments are designed to treat the conifers located in the understory and not influence shade provided by the overstory.

While stand conifer canopy cover and TPA in these units would decrease as a result of the proposed activities, the importance of that reduction on shade varies as a function of the above factors. Stream temperature would either maintain its existing condition or improve under Alternative 2, with the exception of pockets (non-commercial thinning) where shade is reduced over the short-term (3-5 years) until a higher quality shade (dense woody riparian vegetation) could establish in the disturbed gaps. The treatment is designed to thin conifers up to the streambank that occur in the understory (less than 10 inch dbh) of an existing canopy. Long-term (5-20 years) with the establishment of dense woody vegetation, stream temperature conditions would improve under Alternative 2.

Shade providing vegetation is primarily broken into two zones, the primary and secondary shade. Primary shade zones typically occur from the streambank and extend back 50 feet. There would be a short-term impact to the primary shade zone on approximately 670 acres of the 3,745 acres of RVR treatments in RHCAs to water temperature that would last approximately 3-5 years. The treatments within this zone would remove understory size classes, but has the potential to reduce some streamside shading for 3-5 years until riparian hardwoods get established and provide higher quality shade (riparian hardwoods have more layers of vegetation directly over stream with higher leaf area than conifers). A PDC has been developed to minimize water temperature impacts of NCT treatments so that no more than 25% of the total RHCA area does not receive a treatment. Implementation of this PDC will moderate the short-term water temperature impacts over time so that they don't occur at once to water quality impaired streams. RVR treatments are proposed in each of the watersheds, except Trout Creek. Pile Burning

Pile burning will occur in the Upland and RVR Units. The impacts of pile burning will be minimized by use of PDCs. Within the RHCA pile burning will be limited to piles four feet high and six feet in diameter, composed of material generated within the RHCA. Machine work will be separated from the stream by a road at least 100 feet away from the channel for a Category 1 stream and at least 75 ft away from the channel for a Category 2 stream. The proposed action and the PDCs will eliminate sediment and nutrients from entering streams.

Existing and Temporary Roads: Maintenance, Construction, and Haul

Under Alternative 2 there would be 38.5 miles of temporary roads distributed across the project area. Any additional road crossings would be built according to the PDCs and the LRMP guidelines (USFS 1990) and would therefore not cause impacts to water quality within the streams.

Soil Water Available to Plants

Existing roads: Soil compaction on existing roads is currently high and infiltration rates very low. Therefore soil water available to plants is currently low. There would be no change from existing condition as a result of maintenance and use of existing roads due to no change in soil compaction.

Temporary roads: There would be new linear areas of soil compaction, soil displacement, and reduced infiltration rates as a result of the 38.5 miles of new temporary roads. Upon completion of the harvest

activities, the temporary roads would be closed to public access and would be scarified, seeded, and mulched. However, depending on the soil type, soil depth and the amount of compaction, this may or may not be sufficient to restore infiltration capacity or subsurface flow paths. Luce (1997) found that road infiltration rates rapidly dropped after one or two rainstorms even when the road was ripped or ripped and then mulched. The disturbed areas represent only a small percentage of the project area and are not expected to have any measurable effects on the overall AWC values within the subwatersheds.

Channel Morphology

Existing roads: No effect to channel morphology because the fillslopes along stream channels are well-vegetated and stable. Any changes have already occurred and are part of the existing condition.

Temporary roads: There would be a very localized (road width) change in the channel morphology at the road crossing site, but it would not result in bank destabilization because of the PDCs related to constructing a crossing. Upon completion of the project, the banks would be reformed to match the channel.

Channel Complexity (inchannel wood, debris jams and pool frequency)

Existing roads: No effect to channel complexity due to: 1) the open roads are existing and trees do not occur on the road template; and 2) closed roads tend to have small trees, if present, and their potential contribution to inchannel wood is low.

Temporary roads: No effect on channel complexity because the roads occur outside of true ecological riparian areas, but are located within administrative Riparian Habitat Conservation Areas (RHCAs). Where the roads cross a channel, they would do so at an angle. Their area of influence as it pertains to decreasing future inputs of wood is very small (road template). Therefore, the impact of any removal of trees on channel complexity, when evaluated at the drainage scale, is non-measurable.

Channel Substrate

Eliminating a source of fine sediment inputs would help decrease the percent fines in the channel substrate.

Existing roads: If road sediments were delivered to the stream channels during a storm event sediment loading would occur. However, the potential for inputs would decrease under Alternative 2 as a result of upgrading and placement of additional road drainage features and upgrading road surfaces. These would prevent road rutting and would divert water off the road and into the vegetated fillslopes. Therefore, potential inputs would decrease under Alternative 2.

The reduction in sediment inputs from roads would decrease fines in the channel substrate. Inputs of fines from the existing roads during storm events would decrease as a result of the proposed maintenance and the addition and upgrading of drainage features.

Temporary roads: Twenty-eight temporary road segments would be placed in RHCAs. Of the seven temporary roads that would be constructed in category 1 RHCAs, the closest a temporary road would be placed is 140 feet away from a stream. One of these seven temporary roads would be placed on an existing road prism, the other six would require new disturbance. Three temporary roads would be placed in category 2 RHCAs. Two of the three would extend away from the RHCA in the outer sections. One of the temporary roads would be built on an existing road prism. Eighteen temporary roads would occur in Category 4 RHCAs. Three of the 18 temporary culverts would occur on existing road prisms. Sixteen temporary crossings would occur over category 4, dry stream channels.

There is a potential for sediment loading from: 1) channel substrate if road sediments were delivered to the stream channels, and 2) bank instability at the crossings. Road drainage features and surfacing, installed or maintained as part of the Alternative 2, would prevent sediment inputs from occurring. Changes in channel morphology and bank stability at the crossings would limit the road template and be short-termed. Upon completion of the project, the channel banks would be recontoured.

Within the sediment impaired 303(d) listed watersheds (watersheds of Headwaters North Fork Burnt River and Patrick Creek – North Fork Burnt River) and associated streams (Trout Creek and North Fork Burnt River), temporary roads are proposed within the associated RHCAs. No temporary roads are proposed in the sediment impaired Trout Creek Watershed.

There would be no effect on channel substrate because: 1) the PDCs would ensure that stream banks remain stable and are vegetated; and 2) drainage features and surfacing would be installed and maintained as needed to prevent the roads from eroding and contributing sediment into the stream channels. Therefore, there would be no additional sediment entering the streams during storm events.

Stream Flow

Existing roads: Inputs of water from roads during storm events and the spring melt are expected to decrease as a result of upgrading the drainage features and improvements in the road surfacing which divert water onto the fill slopes. However, reductions in stream flow related to the drainage features would be non-measurable because current inputs are low due to existing drainage features and road design.

Temporary roads: No effect on stream flows because channel crossings would be built according PDCs and guidelines in the LRMP (USFS 1990). Drainage features would be installed as needed to prevent these roads from concentrating flow and directing it into a channel. In addition, PDCs would minimize use of the roads when wet and therefore minimize the potential for ruts developing which could funnel water into the channels. The increase in the drainage density as a result of the additional crossings would be minimal and distributed over the project area.

Stream Temperatures

Existing roads: No effects to stream temperatures because the open and closed roads are existing and the road-related changes to stream flows, stream-side shade and groundwater inputs, related to the roads, have already occurred. Maintenance would occur in the road bed and not alter factors influencing stream temperatures.

Temporary roads: Temporary roads are proposed within the RHCAs for temperature impaired 303(d) listed watersheds (Patrick Creek – North Fork Burnt River and Camp Creek). No temporary roads are proposed in the temperature impaired Trout Creek or Antelope Creek – North Fork Burnt River Watersheds. No effect on stream temperatures because stream crossings would be constructed and maintained according to the PDCs. Any change in bank shade would be limited to the template.

Other Project Components

Initiate Natural Regeneration of Aspen

No effects to water resources except for a possible long-term but local increase of the water holding capacity of the soils in the stands. This would be due to increased amount of decaying organic matter on the ground (aspen leaves) and in the soil (roots). However, the effect would be small in area.

Snag and Large Down Wood Debris Creation

Where snag and large down wood debris creation is part of the upland harvest treatments, there would be no measurable effect on water resources because the amount of downed wood and snags would influence only small areas. Increases in the amount of precipitation reaching the ground as a result of these two activities would be small compared the increases that occurred as a result of the harvest, non-commercial thinning and prescribed fire activities.

Where these activities are part of the RVR treatments, the effects would be the same as described under the analysis of RVR units for dropped wood.

Juniper Removal

Juniper Removal occurs in the uplands. The only water resources it has the potential to effect is soil water available to plants. The removal of juniper would increase the amount of precipitation that reaches the ground and is available to infiltrate and would decrease competition for the soil water. Therefore, the effects to soil water would be the same as those described for the upland harvest units.

Fuels Reduction Activities (Non-Commercial Thinning, Prescribed Fire, and Pile Burning)

The analysis for Fuels Reduction Activities addresses both Upland and Riparian Vegetation Restoration Units.

Conifer stands in many of the proposed treatment units are densely stocked with small diameter trees and numerous pockets of large accumulations of both surface and ladder fuels. These characteristics allow for easy transition from surface fires to crown fires and the development of non-typical fire severity stand replacement fires. Non-commercial thinning and prescribed fire would remove trees greater than or equal to 10 inch dbh. Additionally Alternative 2 provides for pile burning and fuels dispersal and removal (FDR).

Under Alternative 2, ladder and ground fuels would be decreased resulting in a reduction in the potential severity and scale of a wildfire. The shift to fire resilient understory as a result of the proposed actions would result in rapid recolonization and resprouting and some ground cover would remain. The effect of decreasing wildfire severity on water resources is discussed below.

Soil Water Available to Plants

The reduction in fuels and subsequent decrease the potential wildfire severity would decrease the potential for soil sealing and increased runoff by retaining some ground cover (Larsen et al. 2009). Therefore, while more precipitation would reach the ground post-fire because of the loss of over and understory vegetation, infiltration, instead of runoff, would be more likely to occur thereby limiting the potential for soil erosion and a loss of top soil. As a result the impacts to soil water would be less and the water-holding capacity and soil productivity of the project area would be greater than the No Action Alternative.

Channel Complexity (inchannel wood, debris jams, pools)

The reduction in fuels and subsequent decrease in potential wildfire severity along and just outside the stream/riparian corridors would potentially decrease the number of standing dead trees while protecting some of the existing in channel wood. The shift to riparian woody plants and aspen, both which typically resprout after a low to moderate severity fire, would result in rapid recovery of live vegetation. Channel complexity would increase from the Alternative 2 treatments and would indirectly be supported through

subsequent natural wildfire events as they would tend to be much less severe and as a consequence, further contributed to riparian plant regrowth and deadwood falling into the adjacent streams.

Channel Morphology

A reduction in fuels and subsequent decrease in potential overall wildfire severity in the stream/riparian corridors would increase the survival chances of bank stabilizing riparian woody plants and their potential in-channel wood supplies. Alternative 2 treatments would encourage fire tolerant riparian plant species to thrive under low and moderate severity wildfires which would in turn also support faster regrowth of this plant community in which post-fire precipitation events would offer roughness to slow surface flows while stabilizing soil profiles along the stream networks within the Project area. Over time, channel bank and bed stability could ultimately become much more resilient to various changes in environmental pressures and potential degrading ecosystem variables discussed here consistently throughout this report.

Channel Substrate

The Water Erosion Prediction Project (WEPP) Model is a physically based erosion simulation model built on the fundamentals of hydrology, plant science, hydraulics, and erosion mechanics. The WEPP Model was used to assess sediment erosion in many of the project area watershed (Figure 6 in Appendix G). Methods used for running the model are summarized in the Soils Report (Young 2019). The analysis results are summarized in Table 27 at the end of the document. The summary shows that pretreatment there is not expected to be sediment erosion. Low amounts of erosion are expected from post treatments in some watersheds including Bennet Creek, China Creek, Geiser Creek, 8 unnamed tributaries to North Fork Burnt River, Earl Spring Creek, Petticoat Creek, King Spring Creek, Camp Creek tributary, and Gimlet Creek. Sixteen of the 38 watersheds analyzed showed a potential for sediment erosion post treatment. This provides for a potential of an average annual total sediment erosion of 0.135 tons per acre across the watershed which is 9.440 average annual tons for the project area.

Alternative 2 treatments propose to thin and reduce both ground and ladder fuels in the treatment units. Along the stream network system within the project area, there are multiple treatment units proposed to reduce potential wildfire severity. Reduction here concerning this capacity decreases soil erosion potential and sediment inputs into the channels because controlled thinning and prescribed burns reduce severity of the uncharacteristic wildfire; hopefully, initiating riparian health and species reproductive success and recruitment. Ground cover and live bank vegetation would be retained and PDCs would be implemented as a result, the amount of fine sediment in the channel substrate is not likely to increase.

Riparian ecosystem function, specifically, herbaceous roughness (i.e. forbs, grasses, downed material) decreasing surface flow energies and root matter holding capabilities to decrease lateral erosion of the stream bank will work towards attainment of desired conditions throughout the project area in regard to channel substrate throughout the stream networks.

Stream Flow

A reduction in finer fuels like small (<1 inch dbh) trees, limbs and brush and the subsequent decrease in potential wildfire severity decreases runoff potential during precipitation events because ground cover would remain, creating surface roughness, promoting infiltration, and preventing soil sealing (Larsen et al. 2009). The proposed activities would result in the expansion of more fire resilient species that would recover more quickly post fire. Therefore, while stream flows could still increase in response to a precipitation event, the amount of peak flow increase would still be less than under the No Action Alternative, providing a more sustained base flow.

Stream Temperatures

A reduction in streamside ground, ladder, and overall finer fuels in the project area decreases potential wildfire severity in these areas and actively selects for those early seral riparian plants. Recovery of the treated riparian patches would be faster under these proposed, low to moderate severity burns and mechanical treatments compared to a potential wildfire; or high-severity burns. Therefore, while some increase in stream temperatures could be temporarily expected post-treatment, the increase would be less than that of the No Action Alternative. As noted by Leach and Moore (2010), net radiation below standing dead trees was twice that modelled for the pre-fire canopy cover. The retention of some live riparian woody plants and overstory, therefore, would decrease the impact to stream-side shade compared to the No Action Alternative.

Cumulative Effects Under Alternative 2

Past, present and reasonably foreseeable activities in the project area that have the potential for effects to overlap in time and space with the proposed actions are current livestock grazing, water diversion, recreation, woodcutting, road maintenance, and wildfire suppression and historic mining. However, only current livestock grazing and larger water diversions for irrigation and mining have the potential for measurable cumulative effects because of the scale of their use and types of impact to stream/riparian areas.

Under Alternative 2 there is the potential for a cumulative effect from livestock grazing on 1) stream temperatures, 2) channel substrate, 3) channel complexity, and 4) bank and bed stability because project activities could lead to increased access and use of the riparian vegetation by livestock. Cumulative effects will be minimized by use of grazing management practices which are already in place for the grazing allotments.

Under Alternative 2 there is the potential for a cumulative effect on stream temperature with implementation of the proposed actions and existing larger water diversions for irrigation and mining. The cumulative effects will be minimized long-term by development of dense woody riparian vegetation which will shade the stream and implementation of project PDCs.

When considering potential cumulative effects of livestock with the proposed action, two livestock effects were examined: 1) browse pressure on the riparian woody plants and aspen and 2) trampling of stream banks. Both wild ungulates and livestock browse riparian woody plants and aspen. Livestock impacts to these species appear to be largely confined to late summer and fall (Parson et al. 2003). Cumulative effects will be minimized and eliminated by use of PDCs and grazing management practices which are already in place for the grazing allotments.

ALTERNATIVE 3 (Proposed Action with no activities in RHCAs)

Direct/Indirect Effects

Direct and Indirect Effects are similar with Alternative 2 and Alternative 3 for the Upland Harvest Units. The effects would vary between Alternative 2 and 3 for the Riparian Vegetation Restoration (RVR) units, as Alternative 3 would not include harvest activities in the RHCAs. Therefore, the direct and indirect effects of Alternative 3 would be similar to Alternative 1, except in regards to prescribed burning. For prescribed burning in RVR units, the effects would be similar to that of Alternative 2.

The direct and indirect effects of Alternatives 2 and 3 are compared in Table 23, Table 24, and Table 25.

Cumulative Effects

The cumulative effects of Alternative 3 would be similar to Alternative 2 for the Upland Harvest units and less for the RVR units as described in Table 25.

COMPLIANCE WITH EXECUTIVE ORDERS AND INFISH Orders

Clean Water Act

Under Alternative 2 and 3, the project would be in compliance with the Clean Water Act because of the implementation of the PDCs. Project design criteria (PDC) were designed similar to best management practices (BMPs) to reduce impacts to waterbodies. Much of our issues with meeting water quality standards occurred prior to the use of BMPs. ODEQ updated the 303(d) water quality impaired list for the state of Oregon with the 2018/2020 integrated report (ODEQ, 2021). They transitioned from not only listing streams that are impaired, to listing entire watersheds (including all streams therein). Of interest in this compliance are the 303(d) listed streams including temperature impaired streams (North Fork Burnt River and Trout Creek) and listed subwatersheds (Antelope Creek – North Fork Burnt River, Camp Creek, Patrick Creek – North Fork Burnt River and Trout Creek). Also, compliance with 303(d) listed sediment impaired streams (North Fork Burnt River and Trout Creek) and listed subwatersheds (Headwaters North Fork Burnt River, Patrick Creek – North Fork Burnt River and Trout Creek). Essentially all streams are water quality impaired in the project area. Petticoat Creek – North Fork Burnt River is the only subwatershed not water quality listed, but has a 303(d) stream flowing through it, the North Fork Burnt River. PDCs were designed for RVR thinning impacts (shade reductions due to conifer cover reductions near the stream) until riparian hardwoods got established and maintained through the planning for the project. One of the PDCs is for adding coarse wood to these streams to physically block the stream surface, capture sediment and increase hyporheic flowpaths in the treated streams. Another PDC limits the conifer canopy cover to a proportion of the total project area to minimize impacts. These treatments will ensure riparian hardwoods are present in the Patrick Project Area over the longer term (up to about 40 years) and will provide shade if a wildfire occurs, years after the project happens.

Approximately 566 acres of the Trout Creek subwatershed and approximately 639 feet of Trout Creek are located within the project area and the remainder of stream is outside the project area. There are no proposed actions within the Trout Creek Riparian Habitat Conservation Area (RHCA). Since it is a small portion of the stream in the project area and no proposed actions are occurring along this portion of the stream, Trout Creek is not carried forward further in the analysis on temperature or sediment.

The North Fork Burnt River is 303(d) listed for dissolved oxygen (Trout Creek to Unity Reservoir) and pH (Dry Creek to Trout Creek). The proposed action is are not anticipated to impact these water quality impairments.

Executive Orders 11988 (Floodplain Management) and 11990 (Wetlands)

Under Alternative 2 and 3, the project would be in compliance with EO11988 (Floodplain Management) for the following reasons: 1) No commercial mechanical activity would occur with the active floodplain; 2) development and protection of these features would be enhanced by PDCs. The project would also be in compliance with Executive Order 11990 (wetlands) because no commercial mechanical activity would occur within the wetlands and seeps.

INFISH Riparian Goals

Under Alternative 2 and 3, there would be positive movement toward attainment of the INFISH Riparian Goals identified as relevant to the project area (Table 13).

INFISH Riparian Management Objectives (RMOs)

Non-Riparian Vegetation Restoration Units

None of the activities proposed in the upland units would alter any of the Watershed Condition Indicators as the Project activities are outside the range of influence. For more detailed discussion of the effects of activities in these units see earlier discussion under Action Alternative, Direct/Indirect Effects (above).

Riparian Vegetation Restoration Units

Within the 3rd through 6th order streams, five RMOs apply to the forested project area. Two additional RMOs apply to non-forested areas, but are not carried forward within this analysis as the treatment units are forested. Under Alternative 2, pool frequency and channel substrate would move towards attainment in all RVR units. The Alternative 2 activities would not increase percent fines into the channel substrate because of PDCs related to skid trails and landings would minimize bare ground and the development of channelized flow. The large wood RMO would be reached long-term as additional riparian woody vegetation established.

The stream temperature RMO would either maintain its existing condition or move towards attainment. It could gradually move towards attainment through the addition of NCT materials being felled instream and sorting sediment. These NCT materials would form debris jams as flood waters rack them together. As water flows through these debris jams, it incrementally cools water through the process of hyporheic flow. Dense shade offered by riparian hardwoods would also maintain cooler water temperature longer instream. The stream temperature could increase on a short term basis (3-5 years) for a long-term gain of stable, dense shade. This is because treatment would decrease average conifer canopy cover. However, the reduction in canopy cover would be less along the stream because of the presence of riparian woody plants and aspen. Finally, the wetted W/D ratio would maintain existing condition because the system is sediment limited.

The removal of conifer encroachment would result in the expansion of riparian woody plants including aspen. The increase in riparian woody plants along the stream banks would increase bank stability due to its greater rooting density and decrease the contribution of fines from the stream banks (Simon et al 2006). Eliminating a source of fine sediment inputs would help decrease the percent fines in the channel substrate.

PDCs and proposed treatments would lead to increase the amount of riparian woody vegetation, which will provide a long-term increase in large wood material in the channel which would in time lead to increased pool frequency and the development of debris jams. Project treatments under Alternative 2 would also increase near channel shade and compensate for the removal of overstory conifer shade. Over time, increases in riparian woody plants along the stream banks would further increase near channel shade and thus decrease the rate of stream temperature increases with decreasing elevation. The increase in both riparian woody plants and aspen would provide future wood inputs and contribute to the development of both debris jams and pools.

Existing and Temporary Roads: Maintenance, Construction and Use

Existing roads: The only RMO with a potential to be affected would be channel substrate if road sediments were delivered to the stream channels during a storm event. However, the potential for inputs would decrease under Alternative 2 and 3 as a result of upgrading and placement of additional road drainage features and upgrading road surfaces. These would prevent road rutting and would divert water off the road and into the vegetated fillslopes. Therefore, potential inputs would decrease under Alternative

2 and 3. The reduction in sediment inputs from roads would help move the channel substrate RMO towards attainment.

Temporary roads: Two RMOs have the potential to be affected within the 3rd through 6th order streams: 1) channel substrate if road sediments were delivered to the stream channels, and 2) bank stability at the crossings.

Road drainage features and surfacing, installed or maintained as part of the Alternative 2 and 3, would prevent sediment inputs from occurring. Changes in channel morphology and bank stability at the crossings would limit the road template and be short-termed. Upon completion of the project, the channel banks would be recontoured. Therefore, there is no effect of the temporary or existing roads on these RMOs.

Appendix A. Available water/soils raw data.

Table 17. Available Water Capacity (AWC) as a function of Soil Map Unit Symbol (MUSYM)

MUSYM	GIS Acres	TOTAL Soil Profile		TOP Soil Profile	
		Weighted Soil Thickness (inches)	Weighted Average AWC (inches)	Weighted Soil Thickness (inches)	Weighted Average AWC (inches)
4107AO	0.4	60	0.34	2	10.2
0009EW	18.9	72	6.48	22	1.98
0070AW	130.2	79	3.55	0	0
0071EW	32.3	72	5.04	13	0.91
0134AZ	744.1	60	4.20	36	2.52
1704CO	15.9	38	4.94	3	0.39
0703AO	3510.3	60	4.80	4	0.32
0704BO	503.3	60	4.80	4	0.32
0711CO	1010.7	60	5.85	17	0.36
1704CO	15.9	38	4.94	3	0.39
1705BO	1013.3	45	7.65	10	1.70
1706BO	1408.2	67	7.10	3	4.30
1707CO	1973.2	19	2.28	4	0.48
1708BO	1364.6	45	6.30	5	0.70
1708CO	1522.3	45	6.30	5	0.70
1713CN	458	25	3.00	11	1.32
1831BO	159.1	12	1.44	6	0.72
3304AO	0.2	60	10.20	8	1.36
3305AO	767	62	10.54	7	1.19
3305BO	229	62	10.54	7	1.19
3306CO	351.2	42	5.88	6	0.84
3312AO	675.3	60	10.20	4	0.68
3313BO	907.3	60	9.00	4	0.60
3316BO	118.1	60	9.00	4	0.60
3317BO	554.4	42	7.14	6	1.02
3317CO	591.8	42	7.17	6	1.02
3319AO	197.6	16	1.12	8	0.56
3320BO	158.1	36	2.16	12	0.72
3433AO	255	45	3.15	20	1.40
3347CO	1.7	31	3.72	13	1.56
3360CO	9.9	34	4.42	7	0.91
3433AO	123.1	45	3.15	11	0.77
3453CS	39	16	1.44	8	0.72

MUSYM	GIS Acres	TOTAL Soil Profile		TOP Soil Profile	
		Weighted Soil Thickness (inches)	Weighted Average AWC (inches)	Weighted Soil Thickness (inches)	Weighted Average AWC (inches)
4105AO	78.7	45	7.20	5	0.80
4105BO	215	45	5.40	5	0.60
4105CO	24.7	45	5.40	5	0.60
4110BO	140.5	60	7.20	4	0.48
4115AO	2901.4	60	9.00	2	0.30
4116BO	1920.7	45	6.30	5	0.70
4117CO	1818.5	45	5.85	5	0.65
4118AO	310.7	37	5.18	3	0.42
4119BO	569.3	37	4.44	3	0.36
4120CO	1289.2	45	7.20	5	0.8
4122CO	165.1	30	2.70	3	0.27
4123AO	29.1	25	2.75	4	0.44
4124BO	704.6	30	3.30	3	0.33
4125AO	180.2	67	11.39	3	0.51
5730CO	922.6	25	3.00	11	1.32
5748CO	445.2	49	5.88	14	1.68
5762AO	117.1	60	7.80	8	1.04
5775AO	154.8	28	4.48	3	0.48
5775BO	279.3	28	4.76	3	0.51
5775CO	602.6	28	4.48	3	0.48
5776AO	81.9	42	6.72	6	0.96
5776BN	180.7	42	7.14	6	1.02
5776CN	30.8	42	7.14	6	1.02
5809AO	39.4	12	1.20	6	0.60
5809BO	16.9	12	1.20	6	0.60
5827AO	600.4	14	1.68	6	0.72
5827BO	2014.8	14	1.82	6	0.78
5830BO	151.5	25	3.00	11	1.32
5830CO	1707.8	25	3.00	11	1.32
5830DO	24.3	25	2.50	11	1.10
5834BO	48.1	25	3.00	11	1.32
5836AO	627.4	7	0.70	2	0.20
5836BO	696.5	7	0.77	2	0.22
5840CO	497.5	12	1.08	6	0.54
5845AO	180.3	7	0.70	2	0.20
5845BO	560.9	7	0.70	2	0.20

MUSYM	GIS Acres	TOTAL Soil Profile		TOP Soil Profile	
		Weighted Soil Thickness (inches)	Weighted Average AWC (inches)	Weighted Soil Thickness (inches)	Weighted Average AWC (inches)
5846CN	1905.9	12	1.32	6	0.66
7307BO	30.8	31	3.41	2	0.22
7318NO	25.2	55	6.60	18	2.16
7323CO	27.7	48	4.80	7	0.70
7341BO	5.6	37	4.44	5	0.60
7344CO	16.7	48	5.28	7	0.77
7556BO	46.3	57	6.84	4	0.48
7556CO	9.2	57	7.41	4	0.52
7709BO	18.5	17	1.36	5	0.40
7712BS	1674.4	34	3.74	6	0.66
7713AO	153	34	3.40	6	0.60
7713CS	3106.7	89.2	3.40	6	0.60
7714DS	1060.4	34	3.40	6	0.60
7715AO	10.6	39	5.07	11	1.43
7717CN	330.6	46	4.60	9	0.90
7718DN	206.2	60	5.40	8	0.72
7721BN	28	61	7.93	3	0.39
7721CN	14.7	61	7.93	3	0.39
7727BO	121.4	37	4.07	5	0.55
7736BO	267.2	46	5.98	9	1.17
7749AO	6.8	34	4.42	6	0.78
7749BO	22.8	34	4.42	6	0.78
7760CO	104.2	20	1.40	6	0.42
7806CO	22.4	59	6.49	14	1.54
9806OR	30.7	0	0	0	0
9959RO	4.8	79	1.58	0	0

Table 18. Available Water Capacity (AWC) by Subwatershed (SWS) and Soil Map Unit Symbol (MUSYM). Data sources: Soils data from the NRCS Soils database.

MUSYM	Total Acres	Total Soil Profile		Top Soil	
		Weighted Soil depth (inches)	Weighted Average AWC (inches)	Weighted Soil depth (inches)	Weighted Average AWC (inches)
Patrick Creek					
4107AO	0.1	60	10.2	2	0.34
0009EW	9.6	72	6.48	22	1.98
0070AW	55.7	79	3.55	0	0
0071EW	6.4	72	5.04	13	0.91
0134AZ	17.6	60	4.2	12	0.84
0703AO	104.6	60	4.8	4	0.32
0704BO	103.1	60	4.8	4	0.32
0711CO	87.6	65	5.85	4	0.36
1705BO	174.9	7.65	7.1	19	4.3
1706BO	41.9	67	10.05	3	0.45
1707CO	283.5	19	2.28	9	1.08
1708BO	185.3	45	6.3	5	0.7
3305AO	766.2	62	10.54	7	1.19
3305BO	35.5	62	10.54	7	1.19
3312AO	658.6	60	10.2	4	0.68
3313BO	543.1	60	9	4	0.6
3316BO	118.1	60	9	4	0.6
3317BO	265.3	42	7.14	6	1.02
3317CO	315.8	42	7.14	6	1.02
3319AO	161.7	16	1.12	8	0.56
3320BO	15.8	36	2.16	12	0.72
3433AO	113.8	45	3.15	20	1.4
4115AO	1,056.90	60	9	2	0.3
4116BO	366.7	45	6.3	5	0.7
4117CO	511.7	45	5.85	5	0.65
4118AO	217.6	37	5.18	3	0.42
4124BO	225.3	30	3.3	3	0.33
5775BO	24.5	28	4.76	3	0.51
5809AO	7.8	12	1.2	6	0.6
5827AO	11.5	14	1.68	6	0.72
5827BO	335.1	14	1.82	6	0.78
5830CO	96.3	25	3	11	1.32
5836AO	208.9	7	0.7	2	0.2
5836BO	270.9	7	0.77	2	0.22

MUSYM	Total Acres	Total Soil Profile		Top Soil	
		Weighted Soil depth (inches)	Weighted Average AWC (inches)	Weighted Soil depth (inches)	Weighted Average AWC (inches)
5840CO	167.7	12	1.08	6	0.54
5845BO	43.8	7	0.7	2	0.2
5846CN	442.7	12	1.32	6	0.66
7760CO	49.9	20	1.4	6	0.42
Petticoat Creek					
4120CO	0.1	45	7.2	5	0.8
5836BO	46.9	7	0.77	2	0.22
5845BO	219.8	7	0.7	2	0.2
0134AZ	199.6	60	4.2	12	0.84
1704CO	15.9	38	4.94	3	0.39
1705BO	494.6	45	7.65	10	1.7
1706BO	363.1	67	10.05	3	0.45
1707CO	408	19	2.28	4	0.48
1708BO	544.5	45	6.3	5	0.7
1708CO	371.4	45	6.3	5	0.7
1713CN	458	25	3	11	1.32
1831BO	159.1	12	1.44	6	0.72
3305AO	0.8	62	10.54	7	1.19
3305BO	188.9	62	10.54	7	1.19
3306CO	346.6	42	5.88	6	0.84
3433AO	13.8	45	3.15	11	0.77
3453CS	39	16	1.44	8	0.72
4110BO	140.2	60	7.2	4	0.48
4115AO	738.4	60	9	2	0.3
4116BO	788.9	45	6.3	5	0.7
4117CO	385	45	5.85	5	0.65
4119BO	399.4	37	4.44	3	0.36
4120CO	474.7	45	7.2	5	0.8
4124BO	334.3	30	3.3	3	0.33
4125AO	56.1	67	11.39	3	0.51
5748CO	238.1	49	5.88	14	1.68
5809BO	16.9	12	1.2	6	0.6
5827AO	2.1	14	1.82	6	0.78
5827BO	283.8	14	1.68	6	0.72
5830BO	107.9	25	3	11	1.32
5830CO	640.1	25	2.75	11	1.21

MUSYM	Total Acres	Total Soil Profile		Top Soil	
		Weighted Soil depth (inches)	Weighted Average AWC (inches)	Weighted Soil depth (inches)	Weighted Average AWC (inches)
5830DO	24.2	25	2.5	11	1.1
5836BO	202.2	7	0.77	2	0.2
5845AO	9.3	7	0.7	2	0.2
5846CN	327.6	12	1.32	6	0.66
9806OR	20.9	0	0	0	0
Trout Creek					
0009EW	3.9	72	6.48	22	1.98
0071EW	10.9	72	5.04	13	0.91
0703AO	294.8	60	4.8	4	0.32
0704BO	22.3	60	4.8	4	0.32
3313BO	1.3	60	9	4	0.6
5836BO	3.6	7	0.77	2	0.22
5845AO	0.5	7	0.7	2	0.2
5846CN	1.2	12	1.32	6	0.66
7712BS	138.1	34	3.74	6	0.66
7713CS	89.2	34	3.4	6	0.6
Headwaters North Fork Burnt River					
4107AO	0.3	60	10.2	2	0.34
0070AW	74.5	72	3.6	13	0.65
0134AZ	93.3	60	4.2	12	0.84
1705BO	335.4	45	7.65	10	1.7
1706BO	1,003.20	67	10.05	3	0.45
1707CO	543.2	19	2.28	4	0.48
1708BO	542.5	45	6.3	5	0.7
1708CO	210.7	45	6.3	5	0.7
3304AO	0.2	60	10.2	8	1.36
3305BO	4.6	62	10.54	7	1.19
3306CO	4.6	42	5.88	6	0.84
3312AO	16.7	60	10.2	4	0.68
3313BO	102.8	60	9	4	1.05
3317BO	268	42	7.14	6	1.02
3317CO	276	42	7.14	6	1.02
3319AO	35.9	16	1.12	8	0.56
3320BO	13.6	36	2.16	12	0.72
3347CO	1.7	31	3.72	13	1.56
3360CO	9.9	34	4.42	7	0.91

MUSYM	Total Acres	Total Soil Profile		Top Soil	
		Weighted Soil depth (inches)	Weighted Average AWC (inches)	Weighted Soil depth (inches)	Weighted Average AWC (inches)
3433AO	123.10	45	3.15	11	0.77
4105AO	28.3	45	7.2	5	0.8
4105BO	215	45	5.4	5	0.6
4105CO	24.7	45	5.4	5	0.6
4115AO	1106.1	60	9	2	0.3
4116BO	588.8	45	6.3	5	0.56
4117CO	877.9	45	5.85	5	0.65
4118AO	36.5	37	5.18	3	0.42
4119BO	135.8	37	4.44	3	0.36
4120CO	212.6	45	7.2	5	0.8
4122CO	5.8	30	2.7	3	0.27
4123AO	29.1	25	2.75	4	0.44
4124BO	145	30	3.3	3	0.33
5762AO	3.5	60	7.8	8	1.04
5775AO	150.5	28	4.48	3	0.48
5775BO	111.8	28	4.76	3	0.51
5775CO	26.6	28	4.48	3	0.48
5776AO	81.6	42	6.72	6	0.96
5776BN	180.7	42	7.14	6	1.02
5776CN	30.8	42	7.14	6	1.02
5809AO	31.6	12	1.2	6	0.6
5827AO	323.6	14	1.68	6	0.72
5827BO	998	14	1.82	6	0.78
5830BO	43.6	25	3	11	1.32
5830CO	925.7	25	3	11	1.32
5834BO	48.1	25	3	11	1.32
5836AO	203.1	7	0.7	2	0.2
5836BO	101.3	7	0.77	2	0.22
5840CO	329.6	12	1.08	6	0.54
5845AO	148.6	7	0.7	2	0.2
5845BO	297.4	7	0.7	2	0.2
5846CN	524.4	12	1.32	6	0.66
7307BO	30.8	31	3.41	2	0.22
7318NO	25.2	55	6.6	18	2.16
7323CO	27.7	48	4.8	7	0.7
7341BO	5.6	37	4.44	5	0.6

MUSYM	Total Acres	Total Soil Profile		Top Soil	
		Weighted Soil depth (inches)	Weighted Average AWC (inches)	Weighted Soil depth (inches)	Weighted Average AWC (inches)
7344CO	16.7	48	5.28	7	0.77
7556BO	46.3	57	6.84	4	0.48
7556CO	9.2	57	7.41	4	0.52
7709BO	18.5	17	1.36	5	0.4
7712BS	76.5	34	3.74	6	0.66
7713CS	307.1	34	3.4	6	0.6
7717CN	113.1	46	4.6	9	0.9
7721BN	28	61	7.93	3	0.39
7721CN	14.7	61	7.93	3	0.39
7727BO	36.9	37	4.07	5	0.55
7736BO	8	46	5.98	9	1.17
7749AO	6.8	34	4.42	6	0.78
7749BO	22.8	34	4.42	6	0.78
7760CO	54.3	20	1.4	6	0.42
7806CO	22.4	59	6.49	14	1.54
9806OR	9.8	59	0	14	0
9959RO	4.8	79	1.58	0	0
Camp Creek					
0009EW	9	72	6.48	22	1.98
0071EW	15	72	5.04	13	0.91
0134AZ	433.6	60	4.2	36	2.52
0703AO	3110.9	60	4.8	4	0.32
0704BO	377.9	60	4.8	4	0.32
0711CO	923.1	60	5.4	4	0.36
1705BO	8.4	45	4.65	10	1.7
1707CO	738.5	19	2.28	4	0.48
1708BO	92.3	45	6.3	5	0.7
1708CO	754.9	45	6.3	5	0.7
3313BO	260	60	9	4	0.6
3317BO	21.1	42	7.14	6	1.02
3320BO	116.7	36	2.16	12	0.72
3433AO	4.3	45	3.15	45	0.77
4105AO	50.4	45	7.2	5	0.8
4116BO	176.3	45	6.75	5	0.7
4117CO	43.9	60	7.8	2	0.26
4120CO	547.7	45	7.2	5	0.8
4122CO	159.3	30	2.7	3	0.27
5748CO	173	49	5.88	14	1.68
5762AO	113.6	60	7.8	8	1.04

MUSYM	Total Acres	Total Soil Profile		Top Soil	
		Weighted Soil depth (inches)	Weighted Average AWC (inches)	Weighted Soil depth (inches)	Weighted Average AWC (inches)
5775AO	4.3	28	4.48	3	0.48
5775BO	143	28	4.76	3	0.51
5775CO	576	28	4.48	3	0.48
5776AO	0.3	42	6.72	6	0.96
5827BO	377.1	14	1.82	6	0.78
5730CO	922.6	25	3	11	1.32
5836AO	19.1	7	0.7	2	0.2
5836BO	115.6	12	1.32	6	0.66
5840CO	0.2	12	1.08	6	0.54
5845BO	0.2	7	0.7	2	0.2
5846CN	610	12	1.32	6	0.66
7712BS	1459.8	34	3.74	6	0.66
7713AO	153	34	3.4	6	0.6
7713CS	2710.4	34	3.4	6	0.6
7714DS	1060.4	34	3.4	6	0.6
7715AO	10.6	39	5.07	11	1.43
7717CN	217.5	46	4.6	9	0.9
7718DN	206.2	60	5.4	8	0.72
7727BO	84.5	37	4.07	5	0.55
7736BO	259.2	46	5.98	9	1.17
Antelope Creek					
3313BO	0.1	4	9	60	0.6
3320BO	12	5	1.8	36	0.3
4118AO	12.7	3	5.18	37	0.42
4119BO	34.1	3	4.44	37	0.36
4120CO	54.1	5	7.2	45	0.8
4125AO	124.1	3	11.39	67	0.51
5748CO	34.1	14	5.88	49	1.68
5827AO	263.2	6	1.68	14	0.72
5827BO	20.8	6	1.82	14	0.78
5830CO	45.7	11	3	25	1.32
5836AO	196.3	2	0.7	7	0.2
5836BO	2.9	2	0.77	7	0.22
5845AO	21.9	2	0.7	7	0.2

Appendix B. Landscape vegetation data.

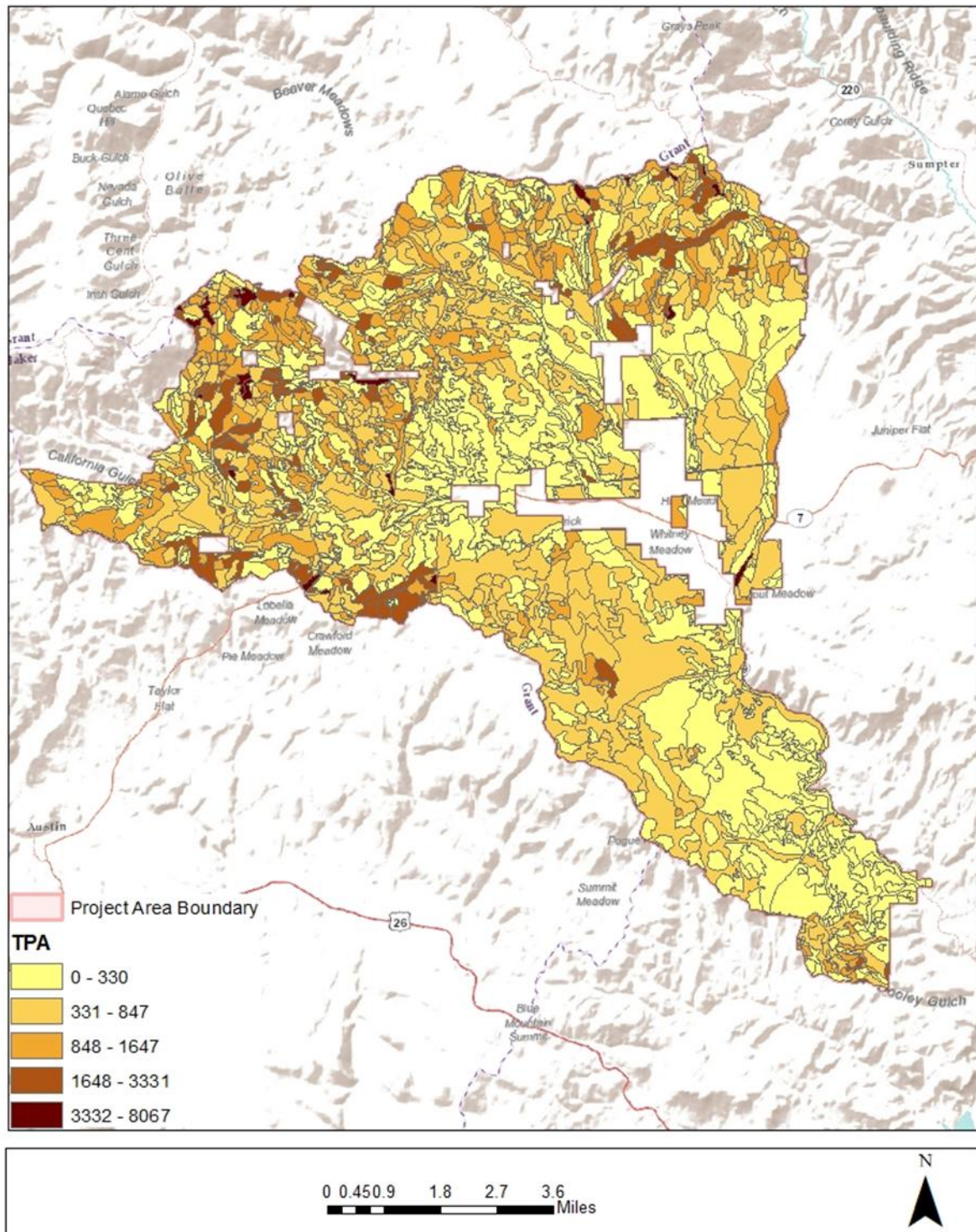


Figure 4. Trees per acre (TPA) in the project area based on the FS Vegetation Data Analyzer Program using Lidar data.

Appendix C. Water Resources Project Design Criteria (PDCs).

Project Design Criteria (PDCs) related to Water Resources

Management requirements are standards that are established to protect forest resources, and are implemented during or after projects to meet Forest Plan and other direction. Project Design Criteria (PDCs) are actions designed for a specific project to reduce or prevent undesirable effects from proposed activities. Project design criteria can include avoiding the effect, minimizing the effect by limiting the action, rectifying the effect, reducing the effect through maintenance, or compensating for the effect. Unless otherwise noted, these management requirements and project design criteria would be incorporated with any action alternative selected for implementation.

Table 19 lists project design criteria and management requirements to minimize the effects of proposed management activities. PDCs are implemented with all applicable units, however some PDCs apply to only select units and in those cases, the units are noted in by alternative in the table below. Effectiveness of implementing these measures is considered to be high for this project. These measures have been used successfully for implementation of past projects on the Wallowa-Whitman National Forest.

Table 19. A subset of PDCs in the EA that will minimize watershed indicators.

Objective	Task
	SOIL RESOURCES
Soil protection - erosion control	PDCs listed in the Soil Report: Patrick Project (Young 2019), including those particularly pertaining to hydrologic resources: Soils 1, 3, 4, 5, 6, 7, 9, 10, 12, 13, 14, 15, and 16.
	WATER RESOURCES AND AQUATICS
INFISH Protection of Riparian Habitat Conservation Areas (RHCAs)	Stream and riparian protection is based on Forest Plan as amended by INFISH. INFISH standards and guidelines related to timber harvest, roads, and fire apply to this project and are incorporated by reference into this document. Category 1 – Fish bearing streams: RHCA consist of the stream and the area on either side of the stream extending 300 feet slope distance from the edges of the active stream channel. Category 2 – Perennial non-fish bearing streams: RHCAs consist of the stream and the area on either side of the stream extending 150 feet slope distance from the edges of the active stream. Category 3 – Ponds, lakes, reservoirs, and wetlands greater than 1 acre: RHCAs consist of the body of water or wetland and the area to the outer edges of the riparian vegetation, or the extent of the seasonally saturated soil, or 150 feet slope distance from the edge of the maximum pool elevation of constructed ponds and reservoirs or from the edge of the wetland, pond or lake, whichever is greatest. Category 4 – Seasonally flowing or intermittent streams, wetlands less than 1 acre, landslides, and land-slide prone areas: This category includes features with high variability in size and site-specific characteristics. At a minimum the RHCAs must include: the area from the edges of the stream channel, wetland, land slide, or land-slide prone area to a distance equal to 50 feet, whichever is greatest.
Protection of water quality – Clean Water Act	Implement and monitor Best Management Practices (BMPs) and incorporate findings into project implementation. Ground based equipment would cross draws and channels at sites pre-approved by the responsible Forest official, and number of crossings would be minimized. Harvest systems would be designed to locate trail crossing at right angles to stream channels. Damaged stream banks and crossings shall be reshaped to stable conditions. Dry stream channels would not be used as forwarder trails, landing sites, or as road locations.

Objective	Task
	<p>Suspend commercial use of National Forest when commercial contract or permit conditions create movement of sediment laden water from the road surface in areas where it could flow into stream channels. This may be from pumping of saturated fines by passage of commercial or contract vehicles, creating sediment laden water on the road surface during rain or snowmelt periods.</p> <p>Timber sale purchaser would prepare a spill containment plan that would ensure that spilled fuel would not leave the site. Fuel would not be stored within any RHCA.</p> <p>Where the proposed haul routes encounter wet areas, new drainage structures and/or surface rock would be installed.</p> <p>Proposed temporary roads would be of low impact and storm proof design – out-sloping, water drainage features, and located on benches where possible to reduce cut/fill construction and sediment risks.</p> <p>Temporary roads would have drainage installed if retained over-winter.</p> <p>Upon completion of project activity, roads would be scarified if required. Berms would be pulled into the roadbed and re-contoured, and the road would be re-vegetated with native seed and mulched with existing slash. Road entrances may be camouflaged to discourage use.</p> <p>Within RVR units: Maintain an average of 100 feet between skid trails. If a forwarder is used, slash would be left in forwarder roads from clearing and product manufacture to create slash mats. Maintain an average of 60 feet between forwarder roads. Material may be skidded to roads. Where roads occur within RHCAs, allow skidding to road when the road is at least 100 feet away from perennial streams, or 50 feet away from intermittent streams. Landings would be rehabilitated to promote vegetation growth. No mechanical fuel treatment piles would be constructed within 50 feet of any channel. For NCT treatments, do not implement more than 25% from the total RHCA acres each year within water temperature impaired subwatersheds to minimize short term shade losses to a 303(d) water temperature impaired stream.</p> <p>Fell all non-commercial thinned coarse wood (less than 10 inch dbh) towards the stream or valley that falls within 50 feet of the stream bank in category 1 RHCAs (approximately the site potential tree zone for 10 inch diameter trees). Directionally fell non-desirable trees under desirable overstory trees away from early seral tree boles. Remove and disperse any limbs from trees cut outside of drip line and remove any tree boles from within 5 feet from desired tree bole. If fuel loadings exceed greater than 15 tons per acre in fuels sizes less than 5 inch dbh, hand piles may be created with excess slash. Minimize coarse wood loading upstream and/or upslope of culverts, irrigation ditches or upstream of private/public land ownership boundaries. If these occur, directionally fell away from infrastructure and remove all felled material away at least 15 feet.</p>
Protection of fish habitat	<p>State of Oregon in-stream work window (July 1 thru October 31).</p> <p>When drafting water, sources would be monitored for reduced flow. During low flow (less than 5 cfs) conditions, spring fed ponds would be used as sources prior to the use of stream sources whenever feasible.</p> <p>During road maintenance and snow plowing, side cast of materials would not occur where these materials could be directly or indirectly introduced into a stream, or where the placement of these materials could contribute to the destabilization of the slope.</p> <p>Slough and waste materials removed during road maintenance activities, including ditch and culvert cleaning, would be deposited in approved disposal sites outside RHCAs. For erosion control and stabilization, the disposal site would be seeded with native seed.</p>

Objective	Task
	<p>Ditches would only be maintained where the water captured by the ditch is not able to be transported to the adjacent drainage structure that carries the water across the road.</p> <p>Refueling, repair, and maintenance of equipment would be done at landings or on forest roads outside of RHCAs.</p> <p>Within RHCAs-</p> <p>Road reconstruction would limit vegetation modification to the road prism, road surface, and ditch lines to that work necessary to maintain a safe travel way and functional drainage system. Utilize existing non-NFS road templates where possible.</p> <p>Temporary culverts would be removed and hauled from the project area. Banks of crossings would be reshaped to match undisturbed sections adjacent to the crossing.</p>

Appendix D. Climate raw data.

Table 20. Precipitation values by month for the six subwatersheds based on the PRISM model.

Month	Headwaters North Fork Burnt River		Patrick Creek		Petticoat Creek		Trout Creek		Antelope Creek		Camp Creek	
	5151 ft	4531 ft	5502 ft	4344 ft	4593 ft	4380 ft	4383 ft	4593 ft	4380 ft	4383 ft	5915 ft	4249 ft
	(inches)	(inches)	(inches)	(inches)	(inches)	(inches)	(inches)	(inches)	(inches)	(inches)	(inches)	(inches)
January	3.6	3.06	3.74	2.59	2.67	2.12	2.32	2.67	2.12	1.94	3.54	2.27
February	2.69	2.21	2.84	1.88	1.97	1.51	1.69	1.97	1.51	1.38	2.76	1.63
March	2.43	1.87	2.65	1.69	1.89	1.51	1.71	1.89	1.51	1.42	2.68	1.57
April	1.89	1.46	2.06	1.34	1.5	1.22	1.38	1.5	1.22	1.15	2.1	1.26
May	2.1	1.72	2.27	1.66	1.84	1.66	1.78	1.84	1.66	1.58	2.37	1.66
June	1.55	1.34	1.65	1.33	1.44	1.32	1.45	1.44	1.32	1.25	1.72	1.37
July	0.75	0.65	0.8	0.67	0.74	0.69	0.76	0.74	0.69	0.68	0.85	0.72
August	0.77	0.7	0.81	0.68	0.71	0.65	0.73	0.71	0.65	0.59	0.81	0.69
September	0.75	0.65	0.8	0.63	0.66	0.56	0.66	0.66	0.56	0.52	0.8	0.62
October	1.3	1	1.43	0.94	1.07	0.89	1	1.07	0.89	0.82	1.5	0.92
November	3.34	2.92	3.45	2.55	2.58	2.07	2.26	2.58	2.07	1.92	3.27	2.24
December	4.32	3.92	4.38	3.31	3.25	2.62	2.72	3.25	2.62	2.53	4.32	2.79
ANNUAL	25.48	21.49	26.89	19.28	20.33	16.84	18.45	20.33	16.84	15.79	26.72	17.74

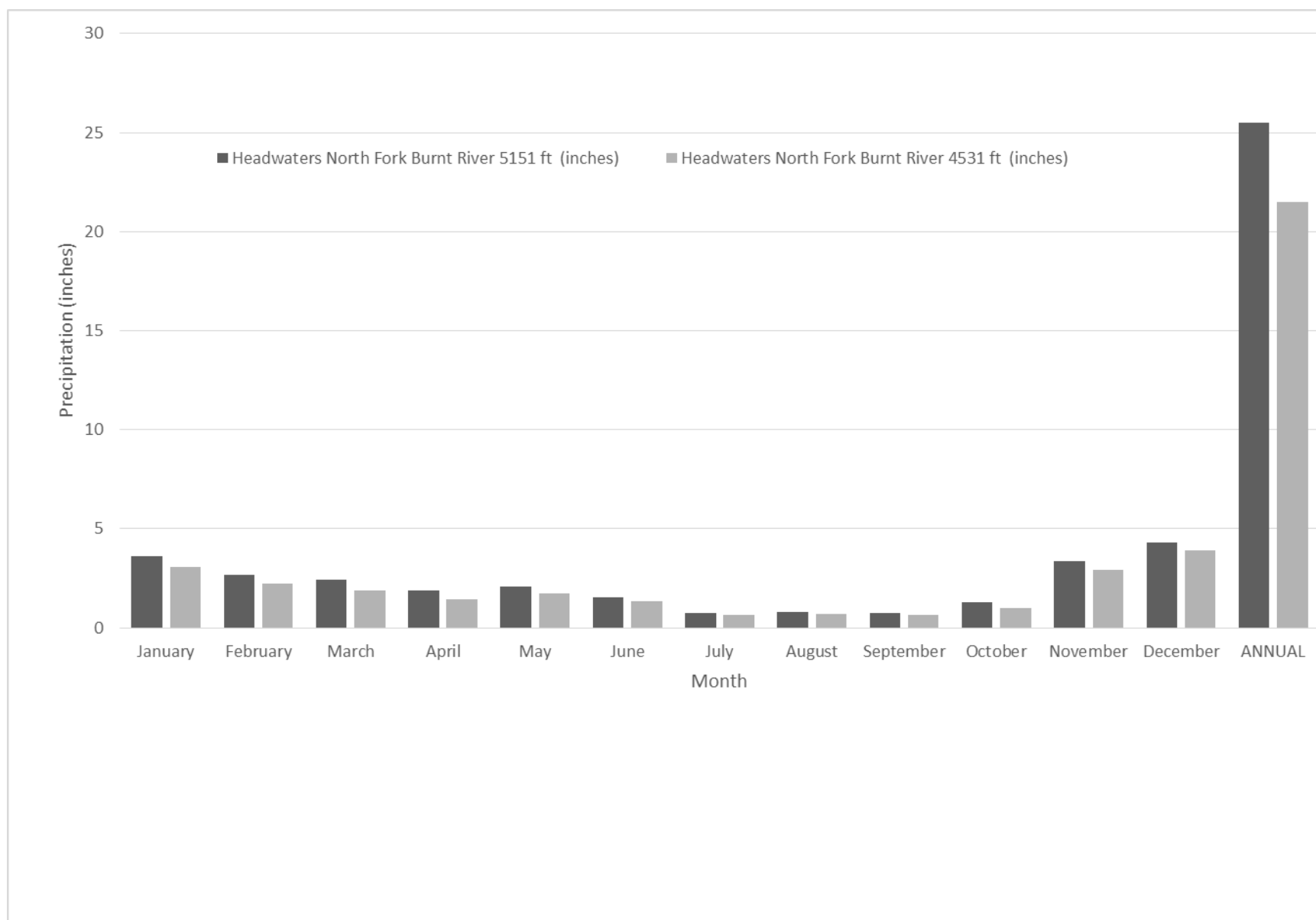


Figure 5. Headwaters North Fork Burnt River watershed precipitation as a function of elevation based on the PRISM model.

Table 21. Mean Maximum and Minimum Air Temperature (°F) by month for six subwatersheds based on the PRISM model.

Month	Headwaters North Fork Burnt River				Patrick Creek North Fork Burnt River				Petticoat Creek- North Fork Burnt River			
	5151 ft.		4531 ft.		5502 ft.		4344 ft.		4593 ft		4380 ft.	
	Mean Max (in.)	Mean Min (in.)	Mean Max (in.)	Mean Min (in.)	Mean Max (in.)	Mean Min (in.)	Mean Max (in.)	Mean Min (in.)	Mean Max (in.)	Mean Min (in.)	Mean Max (in.)	Mean Min (in.)
Jan	32.7	17.8	34	16.3	32.8	18.3	34.5	15.9	34.3	16.5	34.6	16.5
Feb	37.3	18.8	38.9	18	36.9	19.5	39.4	17.8	39	18.1	39.5	18.3
Mar	44.2	23.3	46.6	24.2	43.1	23.7	47.3	24.2	46.6	24.2	47.3	25
Apr	50.8	28.2	53.7	28.6	49.6	28.2	54.6	28.6	53.7	28.6	54.9	29.1
May	59.1	34.3	62	34.7	57.8	34.3	62.9	34.9	62.1	34.8	63.2	35.3
Jun	67.7	39.9	70.5	40	66.3	40.5	71.3	40.1	70.5	40.2	71.7	40.8
Jul	78.7	46.1	81.3	45.2	77.4	48.9	82.1	45.1	81.4	45.9	82.8	46.4
Aug	79	47.1	81.6	44.9	77.6	48.5	82.4	44.4	81.7	45.8	83	46.2
Sept	70	41.5	72.6	39.1	68.8	43.2	73.2	38.7	72.6	39.9	73.7	39.8
Oct	55.8	32.3	58.6	30.5	54.7	33.4	59.4	30	58.6	30.7	59.7	30.7
Nov	39.4	24.2	42.1	23.6	38.8	24.7	42.9	23.4	42.2	23.6	42.9	23.8
Dec	31.3	17.8	33.1	16.3	31.6	18.4	33.6	15.9	33.3	16.6	33.7	16.6

Month	Camp Creek				Trout Creek				Antelope Creek			
	5918 Ft		4136 Ft		4383 Ft		4593 Ft		4628 Ft		4383 Ft	
	Mean Max (in.)	Mean Min (in.)	Mean Max (in.)	Mean Min (in.)	Mean Max (in.)	Mean Min (in.)	Mean Max (in.)	Mean Min (in.)	Mean Max (in.)	Mean Min (in.)	Mean Max (in.)	Mean Min (in.)
Jan	32.8	18.5	34.6	15.7	34.8	15.8	34.3	16.5	34.6	16.5	34.8	16.9
Feb	36.8	19.4	39.8	17.6	39.7	17.5	39	18.1	39.5	18.3	39.5	18.7
Mar	43	23.3	47.7	24.1	47.2	23.9	46.6	24.2	47.3	25	47.3	25.4
Ap	49	28	55	28.6	54.2	28.5	53.7	28.6	54.9	29.1	55	29.4
May	57.1	34.1	63.3	34.8	62.6	34.7	62.1	34.8	63.2	35.3	63.5	35.5
Jun	65.6	39.9	71.7	40	71	40	70.5	40.2	71.7	40.8	71.9	41.1
Jul	76.7	47.2	82.4	44.9	81.6	44.9	81.4	45.9	82.8	46.4	83.1	46.8
Aug	77	47.5	82.7	44.4	82	44.3	81.7	45.8	83	46.2	83.4	46.8
Sept	68.3	41.9	73.4	38.5	72.8	38.6	72.6	39.9	73.7	39.8	74	40.2
Oct	54.3	33.2	59.8	29.6	59.1	29.9	58.6	30.7	59.7	30.7	59.8	31
Nov	38.7	24.5	43.3	23.3	42.9	23.5	42.2	23.6	42.9	23.8	43	24.1
Dec	31.5	18.4	34	15.6	33.9	15.9	33.3	16.6	33.7	16.6	33.7	17.1

Appendix E. Level 2 Stream Survey raw data.

Table 22. Summary of channel widths and depths measured during the stream surveys.

Subwatershed	Creek	*Reach	Miles Surveyed	Av. WW (feet)	Small Wood Pieces	Medium Wood Pieces	Large Wood Pieces	Total Wood >6 inches	Wood per Mile	Pool Count	Pools per Mile	Pool Frequency	Average Pool Depth (feet)	Width/Depth
Headwaters North Fork Burnt River	Cub Creek	160100009 1 Cub Creek	2	7.08	992	181	40	1213	606.5	17	8.5	0.011	1.5	4.72
	Gieser Creek	160100009 1 Cub Creek	2.09	5.37	340	24	11	375	179.4	7	3.35	0.003	1.2	4.48
		160100009 1 Cub Creek	1.44	10.26	16	36	22	74	51.4	18	12.5	0.024	1.8	5.70
	Greenhorn Creek	160000336 1 Greenhorn Cr 94	0.93	6.32	73	130	30	233	250.5	18	19.35	0.023	1	6.32
		160000337 2 Greenhorn Cr 94	1.3	4.64	148	53	32	233	173.2	18	13.85	0.012	1.5	3.09
		160000350 1 Greenhorn Cr 90	0.51	8.26	No Data	No Data	No Data	No Data	No Data	11	21.57	0.034	1.3	6.33
	North Fork Burnt River	4-36.8461 North Fork Burnt River	1.77	12.08	16	2	1	19	10.7	30	16.95	0.039	1.7	7.11

Subwatershed	Creek	*Reach	Miles Surveyed	Av. WW (feet)	Small Wood Pieces	Medium Wood Pieces	Large Wood Pieces	Total Wood >6 inches	Wood per Mile	Pool Count	Pools per Mile	Pool Frequency	Average Pool Depth (feet)	Width/Depth
		160100643 10 North Fork Burnt River 89	0.78	9.91	86	35	3	124	159	13	16.67	0.031	1.3	7.62
		160100644 11 North Fork Burnt River 89	0.33	7.24	No Data	50	27	146	442.4	5	15.15	0.021	1	7.24
		5-38.616 North Fork Burnt River	0.16	6.37	15	0	0	15	93.1	11	68.75	0.085	0.9	7.08
		160100642 9 North Fork Burnt River 89	2.74	11.7	369	135	53	557	203.3	25	9.12	0.02	1.3	9
		3-34.4326 North Fork Burnt River	1.02	11.72	16	5	3	24	23.5	20	19.61	0.044	1	11.72
	Snow Creek	160000355 1 Snow Creek 90	1.83	8.72	274	133	32	439	239.9	53	28.96	0.048	1.3	6.71
		160000334 1 Snow Creek 94	2.3	5.08	575	214	130	919	399.6	33	14.35	0.014	1	5.08

Subwatershed	Creek	*Reach	Miles Surveyed	Av. WW (feet)	Small Wood Pieces	Medium Wood Pieces	Large Wood Pieces	Total Wood >6 inches	Wood per Mile	Pool Count	Pools per Mile	Pool Frequency	Average Pool Depth (feet)	Width/Depth
Patrick Creek-North Fork Burnt River	Patrick Creek	160100694 2 Patrick Creek 90	0.7	15.8	59	24	6	89	127.1	2	2.86	0.009	1.3	12.15
	North Fork Burnt River	1-29.4447 North Fork Burnt River	1.4	11.4	0	2	0	2	1.4	21	15	0.032	1.8	6.33
		160100640 7 North Fork Burnt River 89	1.77	12.69	48	3	2	53	30	20	11.3	0.027	2.5	5.07
Petticoat Creek-North Fork Burnt River	Mosquito Creek	Mosquito Creek - R1	0.87	2.97	21	7	1	29	3.33	42	48.28	0.027	0.7	4.24
		Mosquito Creek - R2	2.13	3.18	74	40	28	142	66.7	28	13.15	0.008	0.7	4.54
	North Fork Burnt River	North Fork Burnt River - R2	2.05	12.15	15	6	5	26	12.7	44	21.46	0.049	1.6	7.59
		North Fork Burnt River - R3	1.95	11.89	40	20	5	65	33.3	27	13.85	0.031	1.6	7.43
		North Fork Burnt River - R4	0.65	21	15	7	4	26	40	8	12.31	0.049	2.6	8.08
		North Fork Burnt River - R4	1.31	13.73	9	5	2	16	12.2	20	15.27	0.04	1.8	7.63

Subwatershed	Creek	*Reach	Miles Surveyed	Av. WW (feet)	Small Wood Pieces	Medium Wood Pieces	Large Wood Pieces	Total Wood >6 inches	Wood per Mile	Pool Count	Pools per Mile	Pool Frequency	Average Pool Depth (feet)	Width/Depth
		160100730 2 North Fork Burnt River 89	2.04	34.18	72	39	3	114	55.9	15	7.35	0.047	1.2	28.48
		160100637 3 North Fork Burnt River 89	1.59	25.49	166	84	15	265	166.7	18	11.32	0.055	2	12.75
		160100503 4 North Fork Burnt River 92	2.84	21.56	126	25	28	179	63	33	11.62	0.48	1.9	11.35
		160100638 4 North Fork Burnt River 89	2.76	20.6	108	58	33	199	72.1	13	4.71	0.018	2.4	8.58
Camp Creek	Camp Creek	160100793 2 Camp Creek 96 Camp	2.07	9.9	62	36	3	101	2.07	33	15.94	0.03	1.9	5.21
		Camp Creek - R1	2.42	5.54	30	6	0	36	14.9	105	43.39	0.046	1.4	3.95
		Camp Creek - R2	3.15	6.12	95	17	0	112	35.6	78	24.76	0.029	1.1	5.56
		160100514 3 Camp Creek 92 X	1.99	3.26	33	82	15	130	65.3	39	19.6	0.012	1.8	1.81
		160100794 3 Camp Creek 96	1.59	11.76	60	20	4	74	46.5	15	9.43	0.021	2	5.38

Subwatershed	Creek	*Reach	Miles Surveyed	Av. WW (feet)	Small Wood Pieces	Medium Wood Pieces	Large Wood Pieces	Total Wood >6 inches	Wood per Mile	Pool Count	Pools per Mile	Pool Frequency	Average Pool Depth (feet)	Width/Depth
		160100727 2 Camp Creek 89	2.01	5.53	26	17	9	52	25.9	35	17.41	0.018	1.9	2.91
		160100516 4 Camp Creek 92 X	0.15	10.48	7	13	0	20	133.3	2	13.33	0.027	2	5.24
		160100627 3 Camp Creek 89	1.46	7.89	47	15	20	82	56.2	16	10.96	0.016	1.5	5.26
		160100796 5 Camp Creek 96	2.36	4.61	236	129	57	422	178.8	7	1.97	0.003	1.2	3.84
		160100795 4 Camp Creek 96	1.32	8.85	43	28	5	76	57.6	7	2.3	0.009	1.4	6.32
		160100628 4 Camp Creek 89	1.33	6.12	108	45	9	162	121.8	17	12.78	0.015	1.2	5.10
	Gimlet Creek	160100680 2 Gimlet Creek 90	1.13	8.04	18	7	4	29	25.7	26	23.01	0.035	1.2	6.70
		160100732 4 Gimlet Creek R 90	1.04	7.28	46	16	6	68	65.4	17	16.35	0.023	1.2	6.06
		160100681 3, 90 Gimlet Creek	1.58	8.23	67	14	9	90	57	37	23.42	0.037	1.2	6.86

Subwatershed	Creek	*Reach	Miles Surveyed	Av. WW (feet)	Small Wood Pieces	Medium Wood Pieces	Large Wood Pieces	Total Wood >6 inches	Wood per Mile	Pool Count	Pools per Mile	Pool Frequency	Average Pool Depth (feet)	Width/Depth
		160100683 6 Gimlet Creek 90	0.14	7.40	12	12	13	37	264.3	2	14.29	0.02	1.1	6.73
		160100682 5 Gimlet Creek 90	1.41	7.26	74	65	57	196	139	25	17.73	0.024	1.3	5.58
	Mosquito Creek	160100690 1 Mosquito Creek 90	0.87	5.08	20	8	5	33	37.9	39	44.83	0.043	1	5.08
		Mosquito Creek - R1	0.87	2.97	No Data	No Data	No Data	No Data	No Data	42	48.28	0.027	0.7	4.24
		Mosquito Creek - R2	2.13	3.18	No Data	No Data	No Data	No Data	No Data	28	13.15	0.008	0.7	4.54
	Pinus Creek	160000487 1 Pinus Creek 96	3.04	5.46	24	6	1	31	10.2	39	12.83	0.013	1.5	3.64
		160000488 2 Pinus Creek 96	2.19	1.62	28	15	8	51	23.3	2	0.91	0	1.1	1.47
Trout Creek	Trout Creek	160100498 1 Trout Creek 92	0.15	35.33	0	1	0	1	6.7	6	40	0.271	4.1	8.62

Appendix F. Summarized effects of alternatives

Table 23. Comparison of Alternatives 1, 2 and 3 RVR units

RVR Prescription	Alt 1 acres	Alt 2 acres	Alt 3 acres
HTH	0	481 (Skyline 216 acre; Ground based 265 acres)	0
NCT	0	3745 (Grapple pile 0; Hand pile 3745 acres)	0
PCT	0	467 (Grapple pile 253 acres; Hand pile 213 acres)	0

Table 24. Summary comparison of direct/indirect effects of Alternatives 2 and 3.

Alternative 2	Alternative 3
1. Increased soil water available to plants due to upland and RVR treatments	Same as Alternative 2, but at slightly smaller scale
2. Increased channel complexity.	No change from existing condition.
3. Increased pool frequency.	No change from existing condition.
4. Increased in in-channel large wood.	No change from existing condition.
5. Maintenance of stream temperature existing condition or possible improvement by decreasing the rate of temperature increases.	No change from existing condition.
6. Increased bank stability. Long-term: increase or remains the same.	No change from existing condition.
7. Maintenance of W/D ratios and possibly some local reductions in ratio and variability.	Same as Alternative 2.
8. Decreased input of % fines into the channel from stream banks due to improved stream bank vegetation and therefore decrease in fines in the substrate over time. Long-term: wild ungulate browse has some effect on riparian woody plants but major inputs from banks not due to instream erosion.	No change from existing condition.
9. Decreased sediment inputs from roads during storm events and therefore decrease in % fines in the substrate.	Same as Alternative 2

Alternative 2	Alternative 3
10. Decreased potential for high severity wildfire with potential adverse impacts to water resources as described above.	Same as Alternative 2

Table 25. Direct/indirect and cumulative effects of Alternative 2 and 3 on Riparian Management Objectives¹

RMO	Stream flow	Direct/Indirect		Cumulative Effect	
		Alt 2	Alt 3	Alt 2	Alt 3
Pool frequency	Perennial only	Moving towards attainment	Maintaining existing condition and trends. Pool frequency continues to be less than the RMO standard.	Cumulative effect occurs but limited to streams bordered by open topography where downed wood not be sufficient to impede livestock browse of riparian woody plants and aspen. These species contribute to pool development by providing in-channel wood.	No cumulative effect.
Stream Temperature	Perennial only	Moving towards attainment in streams bordered by steep hillslopes due to increase riparian woody plants and wood inputs. Maintaining existing condition in streams bordered by open topography.	Maintaining existing condition and trends (stream temperatures exceed RMO standard). Conifer cover would continue to increase with a loss of riparian hardwoods due to lack of light.	Cumulative effect occurs, but limited to streams associated with large water right diversions. Potential cumulative impact until higher quality shade is restored in about 5 years. Impacts will be minimized by the scale of impact across multiple years across the planning area.	Cumulative effect decreases.
Large wood	Perennial and intermittent	Maintaining existing condition with increase in riparian woody vegetation which will long-term lead to an increase in large woody debris.	Maintaining existing condition and trends. Streams remain deficient in wood over the next 20 years.	No cumulative effects.	Same as Alternative 2.
Width/Depth ratio	Perennial only	Maintaining existing condition. W/D ratios continue to be higher than RMO standard.	Maintaining existing condition. W/D ratios continue to be higher than RMO standard.	Cumulative effects occur but limited to streams bordered by open topography where downed wood not sufficient to impede potential channel widening.	No cumulative effect.
Bank stability	Perennial and intermittent	Maintaining existing condition or improving in non-meadow areas	Maintaining existing condition and trends.	Cumulative effects occur but limited to streams bordered by open topography where downed wood not sufficient to impede bank trampling.	No cumulative effect.

Channel substrate	Perennial and intermittent	Moving towards attainment of RMO	Maintaining existing condition and trends. Substrate % fines continue to be higher than the RMO standard.	No cumulative effect.	No cumulative effect.
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1. Lower Bank Angle is not present in the table because it's not applicable in forested stream systems. The Proposed Action proposes to treat conifers with RVR treatments.

Table 26. Direct/indirect and cumulative effects of No Action Alternative, Alternative 2 and Alternative 3 on Riparian Management Desired Conditions.

Riparian Goal Number	Description	Alternative 1: No Action Effects	Alternative 2: Action Alternative Effects	Alternative 3: Action Alternative Effects with no Activities in RCHAs
RG-1	Maintain or restore water quality, to a degree that provides for stable and productive riparian and aquatic ecosystems	NOT met because water stress because water stress from conifers and understory vegetation is expected to increase as both overstory canopy cover and canopy layers increase. There is also an increased potential for catastrophic wildfire events that would likely produce increased amounts of surface runoff and trigger the development of local hydrophobic surface soils and thus; a temporary decrease in the soils' infiltration capacity. Conifer encroachment has displaced riparian hardwoods that provided microclimate and more dense shade. The encroachment and conditions would remain as is.	Moving towards attainment because the decrease in both conifer canopy cover and canopy layers would allow for increased precipitation and light reaching the forest floor; increasing infiltration and the available soil water to support appropriate and diverse native riparian vegetative communities. There would be little to no loss of channel integrity because the riparian vegetation and the understory vegetation that developed as a result of the proposed actions are fire resilient and would re-sprout quickly. Therefore, increased vegetation diversity provides stable root mass to contribute to bank stabilization. As a consequence, sediment inputs due to soil erosion or bank erosion would be less than under the No Action Alternative	Same as Alternative 2, except there may be impacts on channel integrity because the riparian vegetation would not have a chance for regrowth and expansion. Therefore, sediment inputs due to soil erosion or bank erosion would be similar to the No Action Alternative.
RG-2	Maintain or restore stream channel integrity, channel processes, and the sediment regime (including the elements of timing, volume, and character of sediment input and transport) under which the riparian and aquatic ecosystems developed.	No expected change from existing current conditions; however, NOT met if a high severity wildfire occurred because increased soil erosion and inputs into the stream channels post wildfire would degrade water quality and contribute to channel erosion and a loss of channel integrity. These potential effects would represent a change in the sediment regime under which these stream systems developed and under which processes are maintained.	Moving towards attainment as proposed activities would result in an expansion of riparian woody plants, aspen, and cottonwood that would be contributing to instream large woody debris and offer thermal shading. Also, it is expected that the Project treatments would result in increased understory shrubs, grasses, and forbs that would support nutrient filtering and uptake.	Same as Alternative 1.

RG-3	Maintain or restore instream flows to support healthy riparian and aquatic habitats, the stability and effective function of stream channels, and the ability to route flood discharges.	Juniper encroachment is reducing surface flows, due to the high rate of evapotranspiration and outcompeting other riparian vegetation which could stabilize the stream channels and route flood discharges. Conifer encroachment is impeding the expansion of aspen and riparian vegetation, thereby altering the natural runoff timing by not delaying runoff through infiltration and surface roughness.	Moving towards attainment as proposed activities would result in a decrease in canopy cover and stocking level to all for less evapotranspiration and more infiltration.	Same as Alternative 2 outside the RVR units. The RVR units are the same as Alternative 1.
RG-4	Maintain and restore natural timing and variability of the water table elevation in meadows and wetlands.	Juniper encroachment is reducing surface flows, due to the high rate of evapotranspiration and outcompeting other riparian vegetation which could stabilize the stream channels and route flood discharges. Conifer encroachment is impeding the expansion of aspen and riparian vegetation, thereby altering the natural runoff timing by not delaying runoff through infiltration and surface roughness.	Moving towards attainment as proposed activities would result in a decrease in canopy cover and stocking level to all for less evapotranspiration and more infiltration.	Same as Alternative 2 outside the RVR units. The RVR units are the same as Alternative 1.
RG-5	Maintain or restore diversity and productivity of native and desired non-native plant communities in riparian zones.	NOT met because there is an increased potential for uncharacteristic wildfire events that would likely produce increased amounts of surface runoff and trigger the development of local hydrophobic surface soils and thus; a temporary decrease in the soils' infiltration capacity and ability to support/recruit riparian dependent vegetation.	Moving towards attainment because the decrease both canopy cover and layers would allow for increased precipitation reaching the forest floor; increasing the infiltration and as a consequence, the available soil water to support appropriate and native riparian habitat form and function.	Same as Alternative 2, except limitation of native riparian vegetation regrowth and expansion would still be limited by conifer encroachment.

RG-6	Maintain or restore riparian vegetation to:(a) provide a natural amount of large woody debris characteristic of the aquatic and riparian ecosystem;(b) provide adequate summer and winter thermal regulation within the riparian and aquatic zones; and (c) help achieve rates of surface erosion, bank erosion, and channel migration characteristic of the natural system.	NOT met unless a wildfire occurred because it would create a large amount of standing dead wood. This material would be a source of future wood inputs. Existing conifers are young, and their inputs are expected to be low and infrequent. NOT met in project area because dense, stream side shade is limited and conifer encroachment is preventing riparian woody from expanding in places. NOT met where conifer encroachment are replacing riparian vegetation with soil-retention root systems.	Alternative 2 would allow for the expansion of riparian woody and aspen and cottonwoods which would effectively contribute dense patches of near channel and overstory shade. In the event of a wildfire, conditions would be more conducive to rapid recovery of the riparian woody, the supplier of near channel shade. Moving towards attainment because potential the rate of surface erosion and bank erosion if a wildfire occurred would be less than under the no Action Alternative because a large portion of ground cover and bank stabilizing vegetation would be retained.	Same as Alternative 1.
RG-8	Maintain or restore habitat to support populations of well-distributed native and desired non-native plant, vertebrate, and invertebrate populations that contribute to the viability of riparian dependent communities.	NOT met because water stress from conifers and understory vegetation is expected to increase as both overstory canopy cover and layers increase. There is also an increased potential for catastrophic wildfire events that would likely produce increased amounts of surface runoff and trigger the development of local hydrophobic surface soils and thus; a permanent decrease in the soils' infiltration capacity.	Moving towards attainment because the Alternative 2 treatments would allow for an increase in riparian woody species which are limited in the project area; increasing the area's habitat diversity and contributing to the viability of riparian dependent communities.	Same as Alternative 1.

Appendix G. WEPP data.

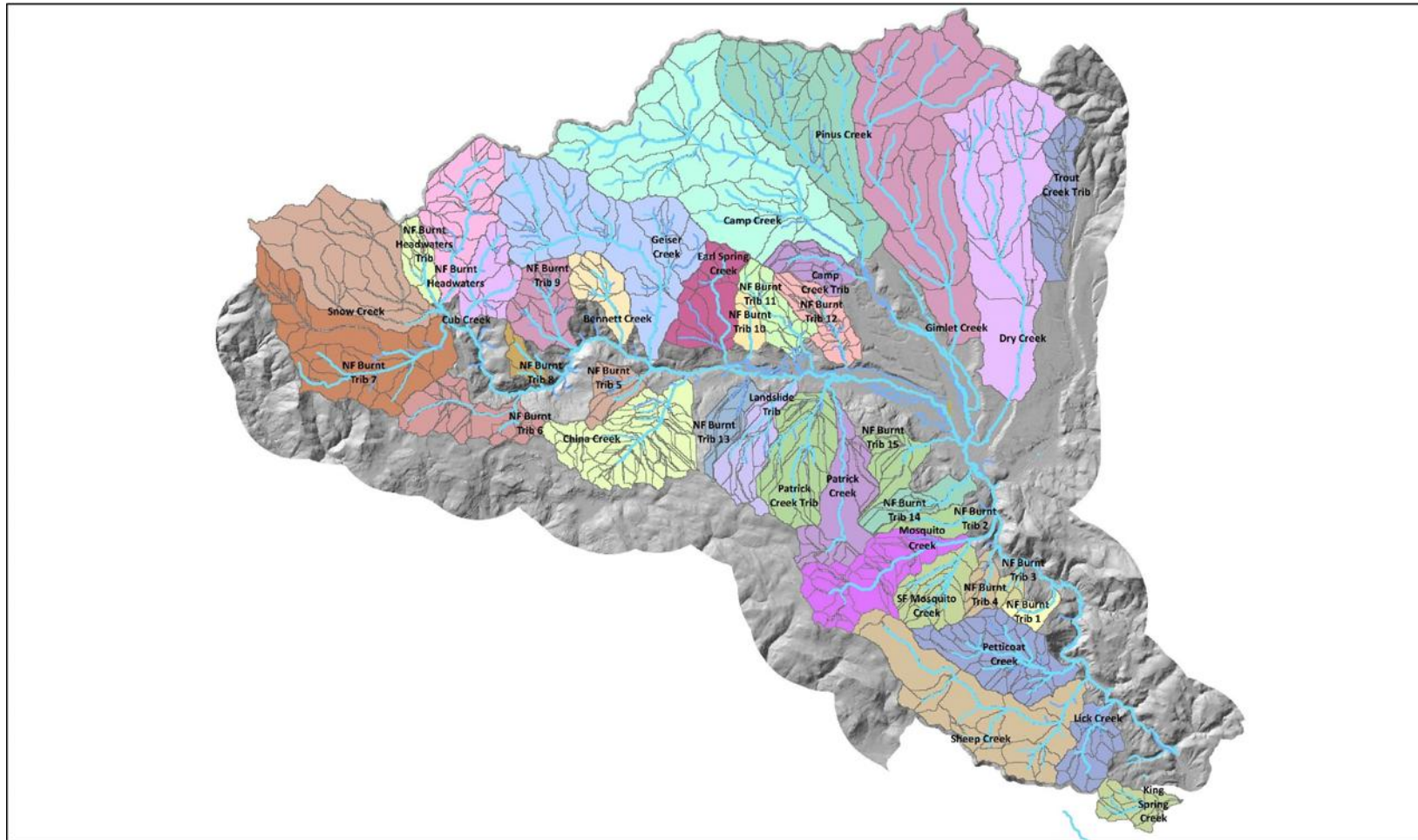


Figure 6. WEPP Watershed analysis locations.

WEPP Project Name		Annual Averages		Return Period						
		Average tons/acre	Total tons	30 year (tons/acre)	30 year (tons)	15 year (tons/acre)	15 year (tons)	6 year (tons/acre)	6 year (tons)	Probability of Occurrence in first year following disturbance
	Post-treatment	0.004	0.130	0.01	4.47	0	0	0	0	3%
TOTALS	Pre-treatment	0.000	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00%
	Post-treatment	0.004	0.130	0.01	4.47	0.00	0.00	0.00	0.00	3.00%
Camp Creek	Pre-treatment	0	0	0	0	0	0	0	0	0%
	Post-treatment	0	0	0	2.04	0	0	0	0	10%
Camp Creek Trib	Pre-treatment	0	0	0	0	0	0	0	0	0%
	Post-treatment	0.004	0.010	0	0.13	0	0.11	0	0	10%
Dry Creek	Pre-treatment	0	0	0	0	0	0	0	0	0%
	Post-treatment	0	0	0	1.79	0	0	0	0	3%
Gimlet Creek	Pre-treatment	0	0	0	0	0	0	0	0	0%
	Post-treatment	0.004	0.510	0	10.14	0	2.54	0	0	7%
Pinus Creek	Pre-treatment	0	0	0	0	0	0	0	0	0%
	Post-treatment	0	0	0	0	0	0	0	0	0%
TOTALS	Pre-treatment	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0%
	Post-treatment	0.008	0.520	0.00	14.10	0.00	2.65	0.00	0.00	10%
Trout Creek Trib	Pre-treatment	0	0	0	0	0	0	0	0	0%
	Post-treatment	0	0	0	0	0	0	0	0	0%
TOTALS	Pre-treatment	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00%
	Post-treatment	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00%
GRAND TOTALS	Pre-treatment	0.000	0.000	0.00	0.74	0.00	0.00	0.00	0.00	

WEPP Project Name		Annual Averages		Return Period						
		Average tons/acre	Total tons	30 year (tons/acre)	30 year (tons)	15 year (tons/acre)	15 year (tons)	6 year (tons/acre)	6 year (tons)	Probability of Occurrence in first year following disturbance
	Post-treatment	0.135	9.440	0.16	269.78	0.09	38.86	0.00	0.00	
		max rate ^		max rate ^						